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COMMUNICATIONS

INTRA-OCULAR FOREIGN BODIES*

Problems of localisation and operative procedure

BY

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Introduction

NOT until this War did the vital importance of the posterior route approach for the extraction of intra-ocular foreign bodies become apparent. The method was not used to any large extent in Britain prior to the War and only to a limited degree elsewhere, but with the advent of new materials of low magnetic properties in the manufacture of instruments of war, and munitions, the posterior route has become the method of choice, except, of course, when the F.B. lies anterior to the lens. Nor is the method likely to fall into disuse after the war, for the employment of metallic alloys of low magnetic properties will extend into peacetime industry and thus experience gained in war should stand us in good stead in peace.

We approach the problem in the full knowledge that contributions have already been made towards a solution in the form both of localisation and operative technique. Advance has been made, but the fact that doubts and queries are constantly being raised, both in conversation between those of us who are together and in correspondence between those of us who are in different theatres

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of war, is enough evidence that unanimity has not been reached on what might be accepted by the majority as the ideal.

The object of this paper, therefore, is first to review what has been done to date, secondly to offer an explanation as to why present methods, because they are scientifically inaccurate, sometimes fail, thirdly to describe a new method of localisation and finally to set out in detail what we believe, in the light of present knowledge, to be the best procedure.

In doing this we realise that much that may be written has already been stated and will be already well known, but to get a complete picture we feel it is essential.

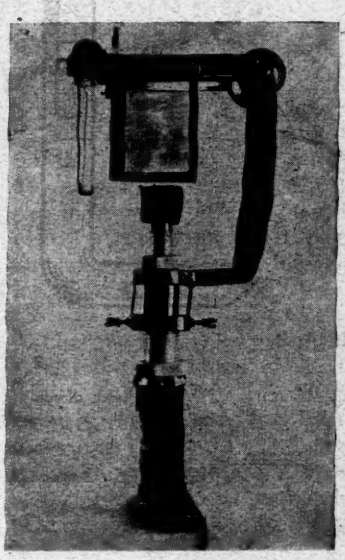
Localisation.—About thirty methods for localising intra-ocular F.B.'s have been devised, some merely fractional variations of others and they have been lucidly classified into six groups in Vol. III of "A Text Book of X-ray Diagnosis" by British Authors.

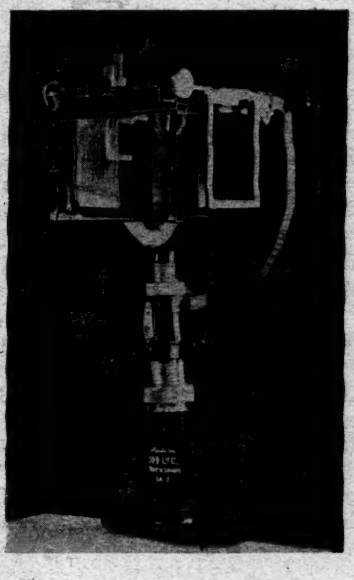
We would mention only the two of which we have experience and are being employed to any great extent, namely Sweet's Localising Apparatus and the "*limbal ring*" method. Of the two there is little doubt that Sweet's is the more accurate but depends on a somewhat complicated and delicate apparatus, of necessity only to be found at a well equipped base hospital. Also when the localisation has been made, the surgeon is presented with a chart showing the exact position of the F.B. but not with a definite measurement, he can make from a fixed point on the globe to that point on the sclera which is nearest to the F.B. he wishes to extract. Nor does it take into account the variation in size between a bigger and a smaller eye, so that a F.B. localised by Sweet's Method to be say on the retina or just outside the globe might require a double exposure X-ray with movement to determine whether it were inside or just outside the globe.

The "limbal ring" method (introduced to the Middle East by C. W. Graham) has the great advantage of simplicity and, in our experience, has worked reasonably well in a high percentage of cases, especially if the radiologist and his staff have been in the habit of dealing with a large number. It has been and still is of great value, but we believe it is not accurate enough when dealing with intra-ocular F.B.'s of low magnetic quality, or non-magnetic F.B.'s. It depends on measurements compared with those of a standard size eye, and though the picture with movement shows whether the F.B. is within or outside the globe (except those situated in Tenon's capsule or an ocular muscle), it does not give an accurate measurement of the distance from the limbus to the incision point on the sclera. It is possible for there to be a very large error in this respect, the importance of which will be revealed in the sections on magnet and diathermy to follow. Even with

a full set of rings it is sometimes impossible to get a perfect fit at the limbus and the mere fact of stitching a ring into position is sometimes interpreted by the nervous patient as an operation and enough to upset him and make the X-ray examination more difficult. Finally, it is sometimes necessary to make several exposures before a true lateral and true postero-anterior view are obtained and the error of rotation of the globe creeps into the picture with movement.

For these reasons we consider that localisation up to now has not been entirely satisfactory, and we submit for consideration





the following method. We believe this method gives the exact position of the F.B. in the particular globe to be operated upon, and also the exact position on the sclera where the incision must be made to be in the closest proximity to the F.B. These measurements produce the optimum conditions for a successful extraction.

There is no need to describe the apparatus in detail as the photographs are self-explanatory. The main principles are as follows:—

(1) A head rest with clamping devices attached, to attain complete immobilisation of the head.

(2) Attached to the forehead cross bar is a small unit designed to work to fine adjustment and carrying the indicators L and F (Fig. 1) which can be moved laterally, up and down, and to and

from the eye. These indicators are partly of radio-opaque and partly of non radio-opaque materials.

(3) X-ray casette holders, and perimeter with spot light.

What follows immediately is purely technical, but is of necessity inserted to explain the geometry of the calculations for those who may be interested. The practical application follows later.

To localise the intra-ocular F.B. and the incision point on the sclera nearest the F.B., one lateral with movements and one postero-anterior X-ray pictures are necessary.

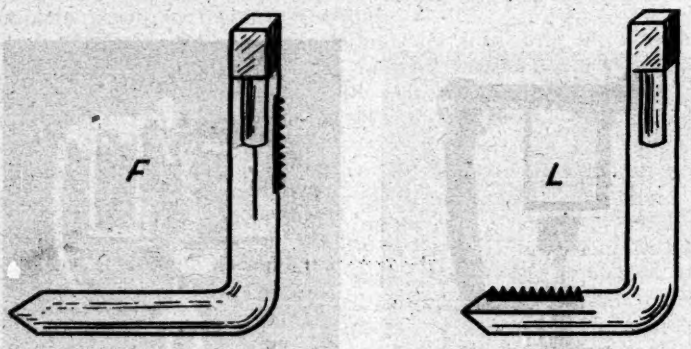


FIG. 1.

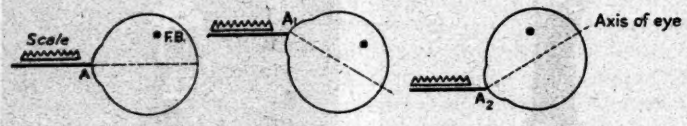


FIG. 2.

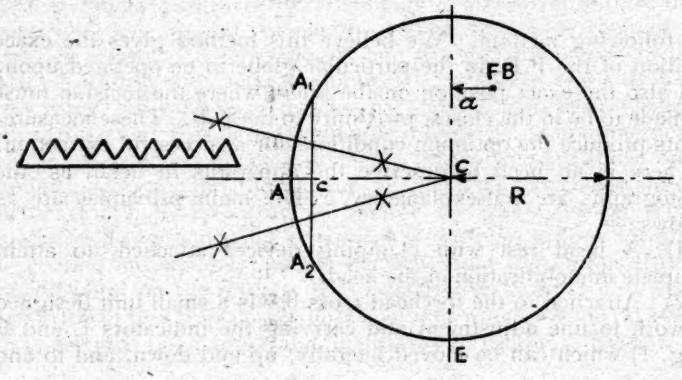


FIG. 3.

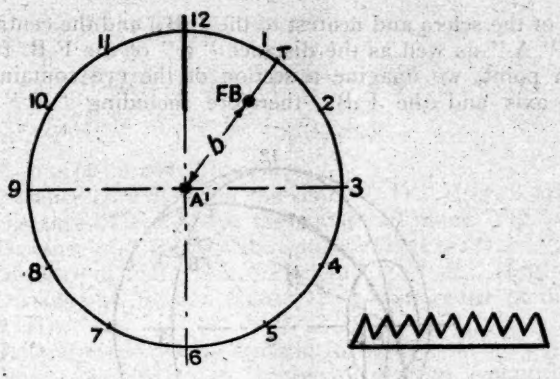


FIG. 4.

To find the diameter of the eye three lateral exposures are taken on the same film, first with the eye looking straight forward, secondly upwards, and thirdly downwards. For each exposure the indicator " L " is placed in contact with the cornea at the centre of the pupil and the scale attached to the indicator shows any magnification, so that true measurements in millimetres can be calculated (Fig. 2). The degrees of upward and downward movement need not, of course, be the same.

The eye has to be assumed to be a sphere tilted between the three exposures about its dead centre and a fixed centre is defined when the head is in a fixed position. The points A, A1, and A2 being given on the films by the indicator, the centre " O " and the radius " R " of the sphere can be easily found according to the laws of elementary geometry (Fig. 3). The centre " O " is at the intersection of perpendiculars dropped from the midpoints of A.A1, and A.A2, and the radius is calculated from the formula.

$$R = \frac{S^2 + 4h^2}{8h}$$

Where " s " is the distance A1 A2 and " h " is the distance AC (Fig. 3), but practically it is enough to measure from centre " O " to A, A1 or A2. The distance " a " of the F.B. from the equatorial plane " E " can now be found (Fig. 3). The distance " b " of the F.B. from axis of the eye and the meridian in which it lies is found from the postero-anterior picture (Fig. 4). This picture is taken with the eye looking straight forward and the indicator " F " in contact with the cornea at the centre of the pupil. The film shows point " A " indicating the axis of the eye, a line at 12 o'clock to give the orientation and a scale from which true measurements in millimetres can be calculated.

To find the distance " y " between the point " P " (on the

surface of the sclera and nearest to the F.B.) and the centre of the cornea " A " as well as the distance " z " of the F.B. from the incision point, we imagine a section of the eye containing the optical axis and the F.B., therefore including " P " and a

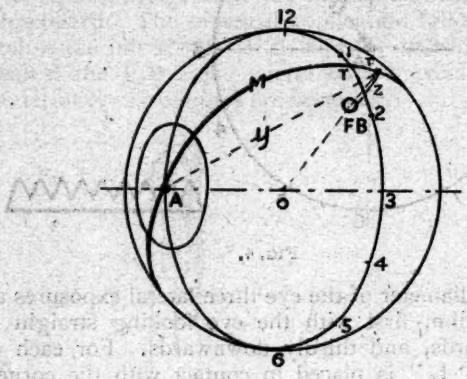


FIG. 5.

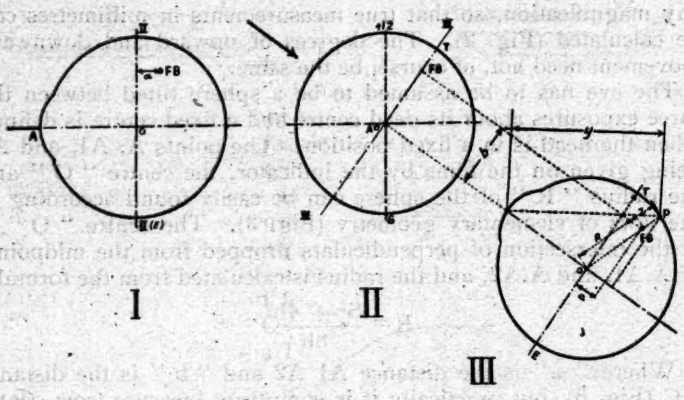


FIG. 6.

meridian " M " which crosses the equatorial line at " T " (1 hr. 15 min. Fig. 4) and naturally the pole (centre " A " of the cornea —Fig. 5).

Fig. 6 shows how the distances of " y " and " z " can be found graphically from the postero-anterior view and that lateral view with the eye looking straight forward, both being drawn on the same scale (if necessary enlarged or reduced). The distance " y " and " z " should be calculated as follows, using " r " the distance between the F.B. and the centre " O."

$$r = \sqrt{a^2 + b^2}$$

$$y = \sqrt{R + \tfrac{aR}{r})^2 + (b\,\tfrac{R}{r})^2} = \tfrac{R}{r}\sqrt{(r + a)^2 + b^2}$$

$$z = R - r = R - \sqrt{x^2 + b^2}$$

R=Radius of the eye (Fig. 3).

r=Distance of F.B. from the centre " O " (Fig. 6 III).

a=Distance of F.B. from the equatorial plane " E " (Fig. 3).

b=Distance of F.B. from the optical axis (Fig. 4).

z=Distance of F.B. from the sclera, *i.e.*, " P " (Fig. 6 III).

y=Distance of incision point " P " from centre of the cornea (Fig. 6 III).

1. Lateral view looking straight forward.

2. Postero-anterior view (perpendicular to equatorial plane " E " (II-II).

3. The contents of the eye seen in the direction of the arrow, representing a section perpendicular to the plane (III-III) which contains the optical axis and the F.B.

Now all the foregoing is purely technical, and what the Ophthalmologist wants, providing he is satisfied that the scientific explanation is correct, is the practical application in as simple a form as possible.

Perhaps the best way is to tackle the X-ray films first. The lateral view shows the indicator " L " and the millimetre scale in three positions, the point of the indicator we know being in contact with the centre of the cornea at each exposure and also it shows the shadow of the F.B. in three positions.

Join by lines on the actual film the end of the indicator in its three positions in contact with the cornea. (A with the eye looking straight forward, A1 with the eye looking up, and A2 with the eye looking down.) Bisect those lines (A1A and A2A) by perpendiculars which will intersect at the exact centre of the eye " O." Draw a circle with centre " O " and radius OA. This circle will naturally pass through A1 and A2 and is the circumference of the eye.

From this you get " R " (the radius of the eye) and the distance " a " of the F.B., in front of or behind the equatorial plane (Fig. 7—F.B. behind the equatorial plane). The F.B. shadow taken is, of course, the one shown when the eye is looking straight forward. Reduce these two measurements " R " and " a " to actual millimetres by comparing any magnification or otherwise with the set scale, also shown on the film.

Now take the postero-anterior view and on this film will appear the central mark of the indicator " F " at " A," a marker at the 12 o'clock meridian for orientation and the shadow of the F.B. Join the 12 o'clock indicator and " A." Describe a circle of any

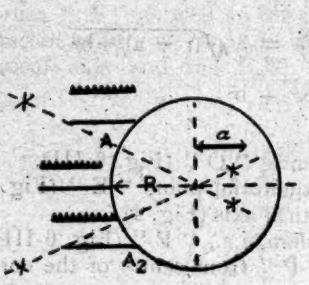


FIG. 7.

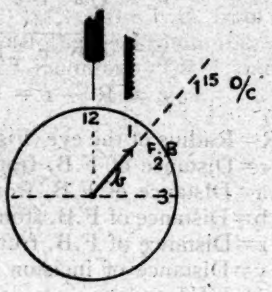


FIG. 8.

radius with a centre at " A." Join this centre " A " with the shadow of the F.B. and prolong to the circumference of the circle. The crossing point of this line and the circumference of the circle gives the exact meridian in terms of a clock face in which the F.B. lies (Fig. 8).

Measure the distance from " A " to the F.B., this will be called " b," and reduce to actual millimetres. This measurement together with the meridian in which the F.B. lies is all one requires from this X-ray film. So that to sum up, from the two X-ray films one can obtain :—

1. Radius of the globe.
2. Distance " a " of F.B. in front of or behind the equatorial plane.
3. Meridian in which F.B. lies from the centre of the eye.
4. Distance " b " from the centre of the eye.

N.B.—All these measurements are of the actual eye, as opposed to other methods which presume a standard eye of 12 mm. radius.

These measurements have been reduced to actual millimetres after allowing for magnification by reference to the scale attached to each indicator.

Now for the plotting. It is easier to work to a large scale and therefore we suggest doubling the measurements already ascertained and dividing the final results by 2. For this reason when distances are referred to, it will be understood they are doubled before plotting (Fig. 9). On a piece of paper describe a circle of radius " R " and " AO " the centre. Mark the 12 o'clock meridian. Along the circumference mark the meridian in terms of the clock face in which the F.B. lies (in the diagram 1 hr. 15 min.), and join this point with centre AO. From the centre AO along the meridian line in which the F.B. lies, measure the distance " b " and mark F.B. From AO and F.B. draw perpendiculars from the meridian line.

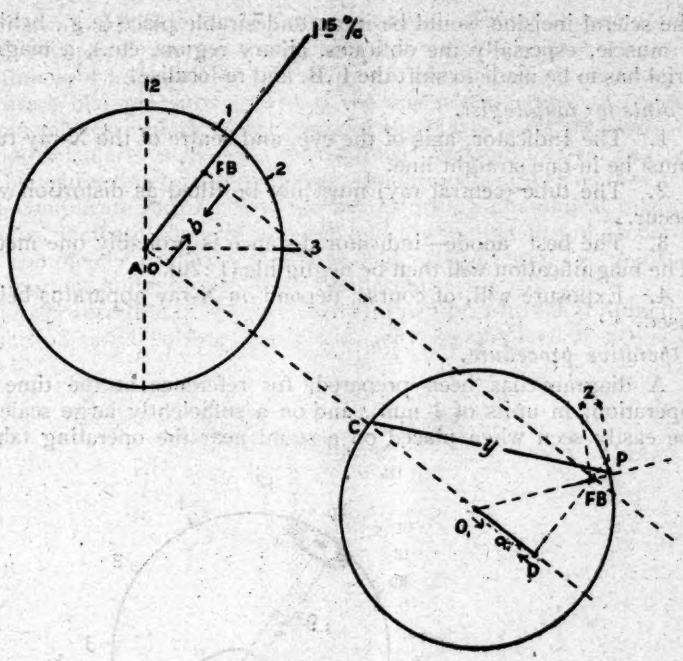


FIG. 9.

On the perpendicular from AO describe another circle of " R " radius sufficiently far distant from the first not to overlap. Let the centre of this circle be " O1." Where this circle cuts the perpendicular AO-O1 will be the centre of the cornea " C." Measure from O1 the distance " a " and call it " D." From " D " draw a perpendicular. Where this cuts the perpendicular already drawn from F.B. (in the first circle) is the real position of the F.B. in the eye. Call it F.B.1. Join O1, and F.B.1, and prolong to the circumference of the circle. There you get a point. Call it " P." Distance " P " F.B.1 equals nearest distance of the F.B. to sclera (" Z "). PC equals distance from the centre of pupil to incision point on the sclera (" y "). To get the distance of " P " from the limbus, deduct the radius of the cornea from PC (" y ").

The distance " a " has to be measured either in front of or behind O1 according to whether the F.B. lies anteriorly or posteriorly to the equatorial plane " E," which will be determined from the lateral X-ray film.

If the localisation shows the F.B. to be in a position where

the scleral incision would be in an undesirable place (*e.g.*, behind a muscle, especially the obliques, ciliary region, etc.), a magnet trial has to be made to shift the F.B. and re-localise.

Points for radiologist.

1. The indicator, axis of the eye, and centre of the X-ray tube must be in one straight line.
2. The tube (central ray) must not be tilted as distortion will occur.
3. The best anode—indicator distance is probably one metre. The magnification will then be negligible (1 :20).
4. Exposure will, of course, depend on X-ray apparatus being used.

Operative procedure.

A diagram has been prepared, for reference at the time of operation, in units of 1 mm., and on a sufficiently large scale to be easily seen when placed on a stand near the operating table.

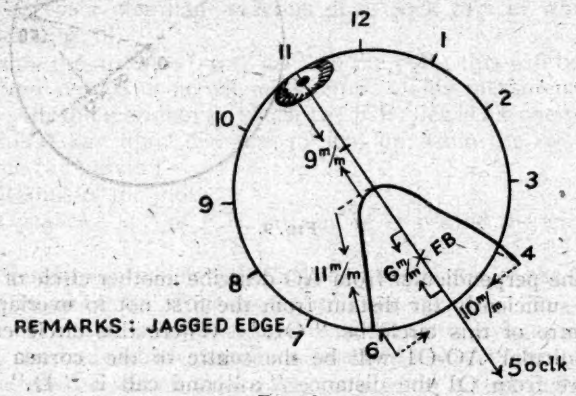


FIG. 10.

Size of F.B., 2½mm.-1½ mm. F.B., Distance from sclera. F.B. meridian, 5 o'clock. Base for conjunctival flap, 10 mm. Distance from limbus to apex, 9 mm. Distance from apex to base, 11 mm. Distance from limbus to marked point for scleral incision, 14 mm. Length of scleral incision, 6 mm.

This diagram should have marked upon it the basic measurements of the particular field of operation such as the limbus, the meridian from the limbus in which the F.B. lies together with the exact location on the sclera through which the incision is to be made, and the size of the conjunctival flap and scleral incision (Fig. 10).

Anaesthetic.

Each surgeon will employ the method of his choice, but we would suggest one or two points which we believe to be essential.

First, in addition to surface anaesthesia a retrobulbar injection of novutox 2 per cent., to which has been added an extra few minims of adrenalin should be given with the object of lowering intra-ocular pressure as well as the anaesthetic effect. Secondly, a facial nerve block at the angle of the jaw or local infiltration of the orbicularis at the external canthus. Subconjunctival and sub-Tenon injections, in our opinion, should not be given as they tend to complicate future procedure by disturbing anatomical relationships, increase haemorrhage and add to the difficulty in preparing a completely dry and bloodless field of operation, a point so important in the proper use of diathermy.

After insertion of the speculum and just prior to the conjunctival incision extra surface anaesthesia may be obtained if necessary

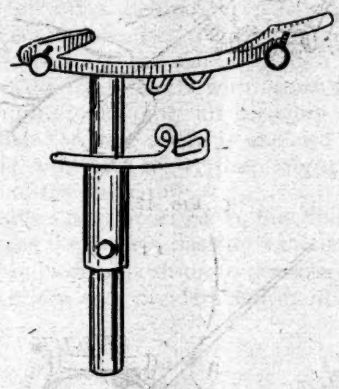


FIG. 11.

by holding a pledget of cotton wool soaked in 5 per cent. cocaine with adrenalin on that part of the conjunctiva about to be incised.

As regards the type of speculum to be used, one relieving the globe of all pressure is the best, such as the Arruga, but a much simpler and lighter one is the Oláh (Fig. 11).

Hereafter the operative technique resembles to some extent that already described by Stallard, but of necessity modified to suit the new localisation with an alteration in the area of diathermy application and a different scleral stitch, the importance of which will become apparent when we come to the actual use of the magnet. We feel therefore that it will not be out of place to spend a moment or two in describing the various stages in some detail.

Mark the meridian on the actual limbus and " o'clock " exactly opposite, *e.g.*, 3 and 9, 5 and 11, 8 and 2, using dividers and a marking needle. Insert a fine silk suture at the mark on the limbus exactly opposite to the already marked meridian (Fig. 12). Tie,

leaving one end about 3½ cms. long. This suture should be greased with sterile vaseline to prevent damage to the corneal epithelium later.

Insert a silk suture in the form of a mattress suture by taking a good bite of conjunctiva, episcleral tissue and if possible the

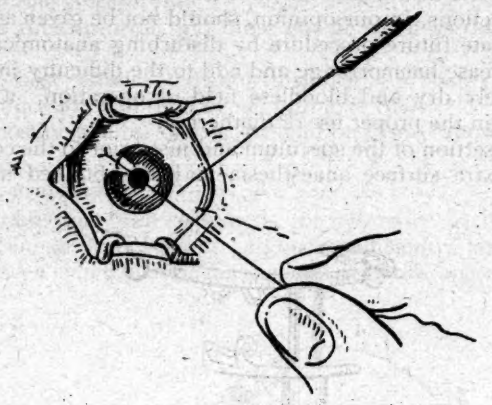


FIG. 12.

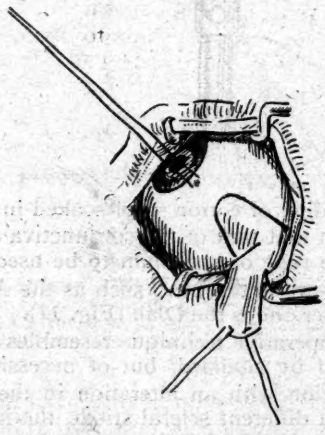


FIG. 13.

sclera about 3 mms. from the limbus, and with one arm on either side of the point marking the line of the meridian in which the F.B. lies (Fig. 13).

This holding suture can be clamped by artery forceps to the head towels, as the traction upon it may need to be varied from

time to time, thus altering the degree of rotation of the globe until the moment arrives to incise the sclera, when it should be used to bring that area of the sclera to be incised as near pointing vertically upwards as possible.

Dissection of conjunctival flap.

It is a mistake to attempt the operation through a small incision, as room is required for manoeuvre and for marking out accurately the required place and size of the scleral incision. Through all the tissues down to the sclera cut a flap, the apex of which points towards the limbus, the base at least 10 mms. broad, and the long axis roughly in the line of the meridian in which the F.B. lies. The apex should be at least 4-5 mms. nearer the limbus than the anterior end of the proposed scleral incision (if possible), and the base should be a few mms. behind the posterior end of the proposed scleral incision. Reflect back together with Tenon's capsule and episclera. Fix the flap with two or three holding sutures clamped to the head towels with artery forceps. Dry the whole field thoroughly, stopping all bleeding points by actual cautery, and see that the bare sclera is exposed without any tags of episcleral tissue adhering to it, that might interfere with a proper application of the diathermy.

Draw the fine silk suture inserted at the time of marking the meridian, taut across the cornea passing exactly over the marked meridian and held in close apposition to the sclera. The assistant now marks on the sclera with dividers and marking needle a point

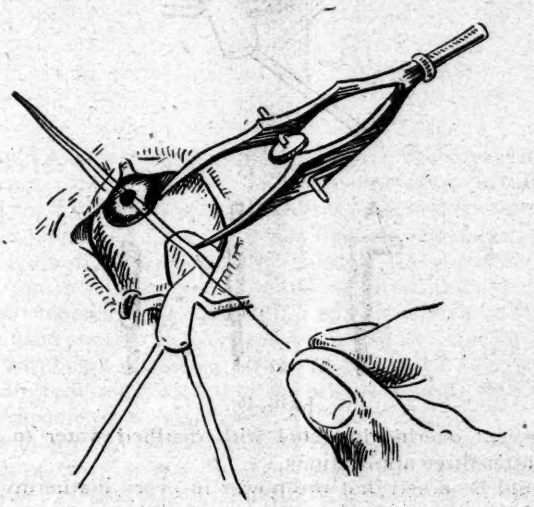


FIG. 14.

at the already known distance between the limbus and the nearest point on the sclera to the F.B. in the line of the silk suture still held in position, he makes two marks each equidistant anteriorly and posteriorly from the first mark, to show the size of the proposed scleral incision (Fig. 14). This will depend on the size and the shape of the F.B., and also the depth at which it lies in the vitreous. (The deeper the F.B. lies, the larger the scleral incision required—see magnetic principles.) The fine silk suture can now be removed.

Diathermy.

Two mm. lateral to each marked point on the scleral and on both sides, surface diathermy is applied (Fig. 15) approximately 100 mps. for 2 seconds (see explanation in diathermy principles). The result should be a coagulation showing bluish-grey like parchment.

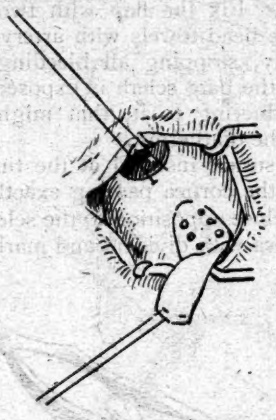


FIG. 15

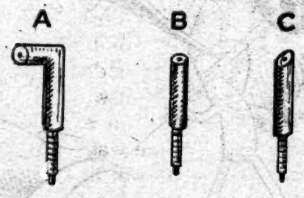


FIG. 16.

To prevent overheating cool with distilled water (a bad conductor), after three applications.

It should be noted that the power in every diathermy machine is variable during operation, so that the amperemeter and result

of coagulation on the sclera must be watched—Fig. 16 shows diathermy points, insulated flush to the end of the metal core which is 1 mm. in diameter.

Scleral incision.

With a Tooke's corneal splitter incise the sclera to a depth of ¾ of mm. along the line of the previously marked three points. Take two double-threaded 6/0 catgut sutures on small needles and insert through the lips of the scleral wound from within outwards, spacing evenly and leaving a large intermediate loop on each (the Mersature eyeless are best). These will be referred to as the omega stitches (Fig. 17).

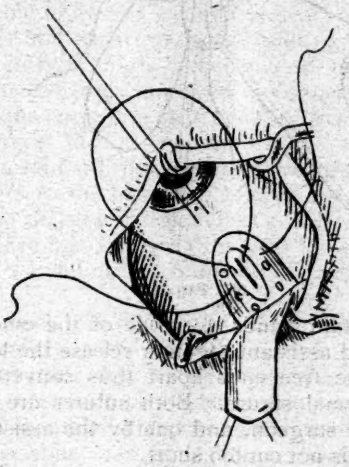


FIG. 17.

With the Tooke's corneal splitter complete the division of the sclera down to the choroid. The assistant takes between the thumb and forefinger of one hand the free ends and corresponding sides of the loops and with the other hand in the same way the other free ends and corresponding sides of the loops, applying gentle traction in an upward and outward direction from the line of the scleral incision (Fig. 18); with a narrow Graefe knife, blade upwards cut the choroid in the same way as an incision for corneal section. The omega stitches must not be released by the assistant until they are required for closing the scleral wound. See that all magnetic instruments are removed.

Place the magnet in position and by foot switch give interrupted applications of two seconds duration at two second intervals. If the F.B. is not extracted after about fifty applications, it is useless to go on (see magnetic principles).

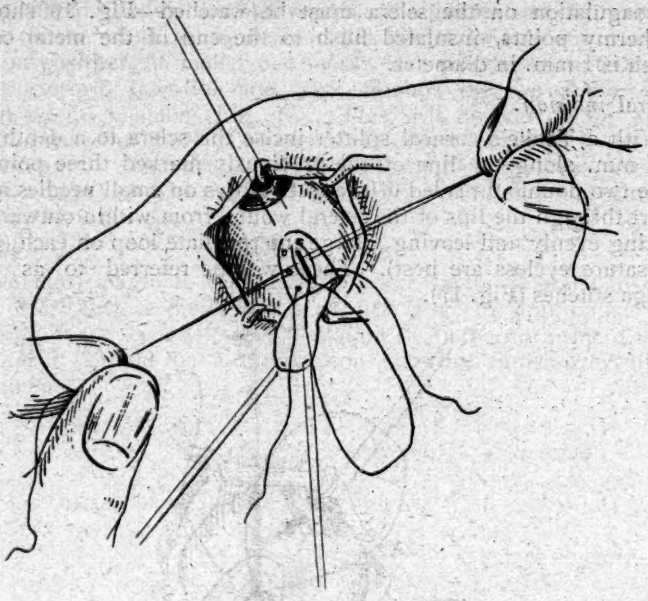


FIG. 18.

Now the assistant hands over one of the omega stitches, and both surgeon and assistant together release the loops, at the same time drawing the free ends apart thus converting each omega stitch into a normal suture. Both sutures are tied at the same time, one by the surgeon, and one by the assistant in a surgical knot, and the ends not cut too short.

Replace the conjunctival flap, having removed its holding sutures and sew into position with a continuous silk suture without knots and leaving a few mms. of free end at the limits of the wound. Remove the final holding suture. Dressings will be according to individual choice, but both eyes should be bandaged and nursing for the first ten days should be as for retinal detachment.

If a muscle has to be divided a " W " stitch is used. This consists of silk threaded through three needles, one at either end, and one at the middle. The middle needle is passed through the

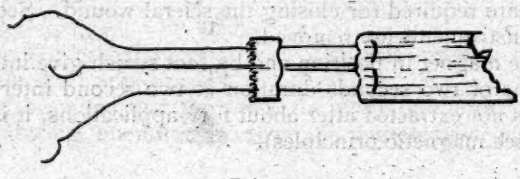


FIG. 19.

centre of the muscle and the needles at each end, 1 mm. internal to the edges (Fig. 19).

Principles of diathermy.

The decision to be made is, what strength of current and what time of application has to be used to avoid complications and at the same time give the required result. That required result has only to be a circumscribed adhesive choroido-retinitis which will lead to adhesion between retina, choroid remains and sclera. For this reason it is not necessary to "cook" a large part of the globe, a process which, as will be explained later, in addition to producing a sero-fibrinous choroido-retinitis, results in opacities and traction bands in the vitreous and coagulation around the metallic F.B., liable to lead to secondary detachment of the retina.

Let us consider the electrical facts resulting from application of a diathermy current (high frequency) to the surface of the sclera. When the electrode is placed in contact with the surface of the sclera and the current is switched on, because the eye is not one even resistance but a combination of multiple unequal resistances, the current will flow according to the law of Kirchhof.

The sclera offers to the current a bigger resistance than other parts of the eye so that the thermal effect will be greater here than elsewhere in the eye (according to the well known laws of repartition of energy in a conductor composed of materials of differing resistances).

Applying the law of Joule ($I^2 \times rt = KH$). Where I = current in amps, r = resistance in ohms, t = time, H = produced calories, K = constant, we find that by doubling the current the same thermal effect in calories is produced in one quarter of the time. Using therefore a stronger current we get a more complete coagulation in a shorter time than by using a weaker current. This coagulation increases the resistance of the sclera to heat conduction. A condition which is required.

By using high frequency current there will be built up in the vitreous a di-electrical field, whereas in the F.B. (metal and a good conductor), there will not occur a di-electrical field and for this reason the greater part of the electrical energy will be concentrated in the metallic F.B., resulting in the production of heat and consequent coagulation around it.

If a body of higher temperature is placed in contact with a body of lower temperature, following the physical law that the temperature tends to equalise, heat will increasingly penetrate the body of lower temperature, but this requires time. In practice that part of the heat which in the process of dissipation tends to penetrate the eye is what we wish to avoid. As the coagulated sclera is a dehydrated tissue it is more heat resistant than the air and surrounding normal tissue.

By applying the diathermy electrode for 6 secs., the produced heat has a greater opportunity of penetrating into the vitreous than if the electrode is applied for one or two seconds only, and this is not proportional to the degree of produced heat. As an example, if we touch the skin for a fraction of a second with white hot metal (approx. 1,000 degrees), a severe but superficial burn will result. Whereas by touching the skin with dull red hot metal (approx. 500 degrees), for a second or longer, the result will be a deep necrosis.

The conclusions to be drawn from this are by using a smaller current for a longer time there could be produced a sero-fibrinous choroiditis with attendant vitreous opacities from the deep coagulation of the tissues and into the vitreous. By a longer application of the current the heat produced will have a greater opportunity of penetrating deeper into the globe and could also be the cause in bigger or smaller degree of vitreous capacities. (We must think always in terms of a circumscribed, sterile, inflammatory process and not in terms of a spreading bacterial or toxic one, *i.e.*, the changes remain practically localised to that degree and area which we have affected by the diathermy.) Too high a strength of current will produce burning which is in every way undesirable.

Most diathermy apparatus in use depends on the high frequency current being produced by spark gap electrodes. The greater the distance between the spark gap electrodes the longer the spark. The shorter spark gives higher frequency and lower voltage, a longer spark will give higher voltage and lower frequency. These two factors, frequency and voltage, determine the kind of coagulation. The optimum length of spark cannot be given dogmatically for every apparatus and must be ascertained empirically for each individual one. The best way of doing this is by the use of a pig's eye and needle electrode. Apply the needle electrode to the cornea of the pig's eye and turn on the current (40 mps.). The needle should penetrate without any force being necessary and after one second when it is removed (the current having first been switched off), an area of 2 mm. in diameter around the needle puncture through the cornea should be white without any blisters. If the spark gap is too long an area of brownish coagulate will show around the needle puncture and will be smaller than 2 mm. in diameter. The cornea will be burnt around the needle puncture and further coagulation prevented from spreading. Instead the corneal tissue may be even heaped up around the needle puncture due to sparking at the needle point and blisters may be apparent. If the spark is too short, a very small white area around the needle puncture will result.

To obtain the proper spark gap, a current kept steady at 40 mps. should be employed, and the spark gap regulator adjusted

until the optimum coagulation is obtained. The spark gap should be checked at fairly frequent intervals for each individual machine and always before use if it has been out of commission for some time.

The above is only for obtaining the requisite spark gap for any form of coagulation and the spark gap has to remain constant for whatever power in amps. it is intended to use.

After setting the spark gap, a further trial for surface coagulation can be made if desired on a pig's sclera, if possible. The result should be a bluish-grey area like parchment as already mentioned in the section on operative procedure.

Principles of magnetism.

The magnets most commonly in use are Giant Magnets, either of the Haab-type or the Mellinger. The former is directly magnetised by the electrical winding around it, and the latter works indirectly through a bar of soft iron which, placed in the magnetic field, becomes magnetised.

For the posterior route extraction of intra-ocular F.B.'s the Mellinger is the more handy, but the Haab has the more powerful pull.

The governing factors as regards the success of extracting a magnetic F.B. from the eye are :—

1. The distance of the magnet from the F.B.
2. The power of the magnet.
3. The magnetic quality and size of the F.B.

Because of the low magnetic quality of the alloys which form such a high percentage of intra-ocular F.B.'s in this war, it is essential to use a powerful magnet and apply it as near as possible to the F.B.

The loss of magnetic power by increasing the distance from magnet to body, practically is equal to the cube of that distance. So if the pulling power of a magnet at 1 mm. distance is say 1 gram., then by increasing the distance to 2 mms. the pulling power becomes only $\frac{1}{8}$ of a gram., at 3 mms. 1/27 gram., at 4 mms. 1/64 gram., and so on. Nearer than 1 mm. the pulling power increases out of all proportion up to actual contact. The reason for this is that the body comes only into the small central core of the magnetic field, extremely limited, the rest of the magnetic field being lost (Fig. 20). The larger the body the more magnetic lines will reach it, and the stronger will be the pull (Fig. 21).

Up to date the power of only one pole of a magnet is used and possibly if both poles could be used the pulling power would be much increased because of the increased density of the magnetic field, but there are difficulties in constructing a bi-polar magnet for use in eye work (Fig. 22).

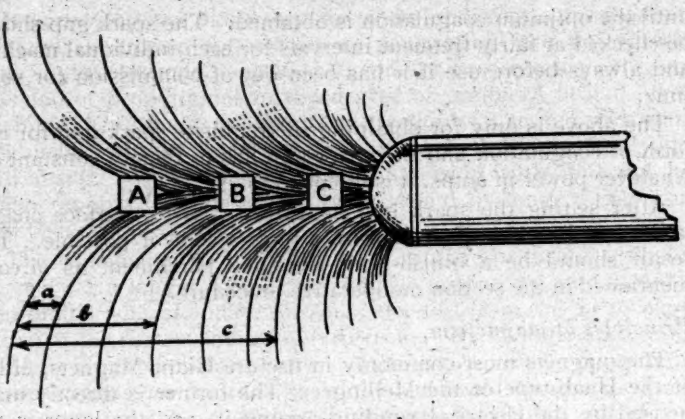


FIG. 20—distance factor.

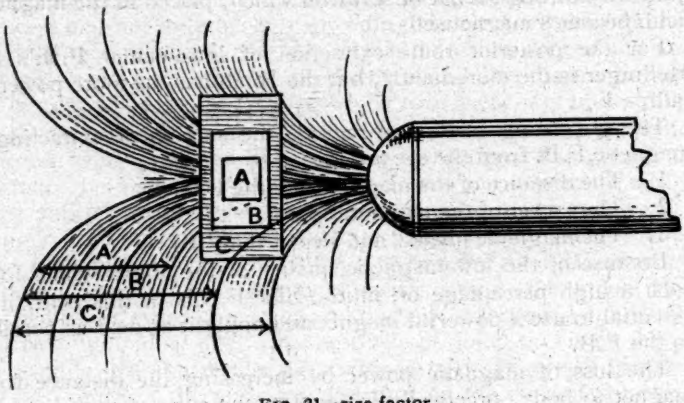


FIG. 21—size factor.

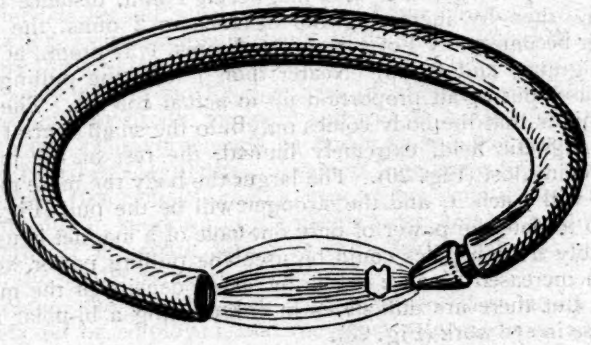


FIG. 22.

The next question is one of points. If a Mellinger is used, a thin iron bar is easy to manipulate, but has a small capacity for saturation, and in consequence its pull is poor. But use of a thick iron bar has also its limitations depending upon the strength of the magnetic field, which can only saturate a certain size. The efficiency of the Haab also depends upon the choice of points. The strongest point is one with a blunt end and about as broad as it is long because the most powerful pull is exerted from the centre of the point where the density of the magnetic field is greatest. At the sides, the magnetic lines do not reach out towards the F.B. and so are wasted (Fig. 23). The point which is weakest is the long thin one because so much wasting of power takes place from the sides right up to the end.

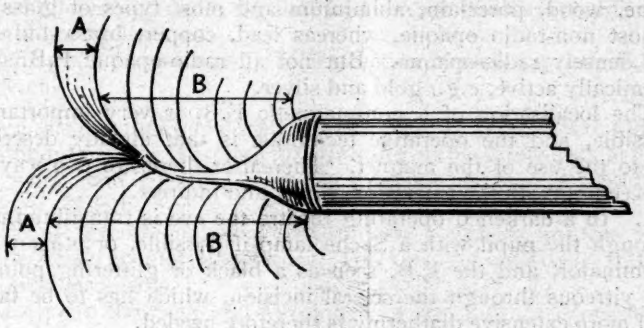


FIG. 23.

A—effective magnetic power. B—wasted magnetic power.

The decision to be made is, can we come so much nearer to the F.B. with a long thin point than with the blunt one to make the use of the former worth while? As stated previously, the pulling power increases so vastly from 1 mm. up to actual contact that if by using a point even not thicker than say a blood needle we can actually contact the F.B. with it, then it will be better than using a blunt point (*e.g.*, if an F.B. is 4 mms. deep from the sclera and by using the long thin point we can come to within a half mm. of it, then we increase the pulling power by about 500 times or more). This applies to F.B.'s of low magnetic quality, as an iron or steel F.B. could be extracted even at 10 mms. distance by a Haab or Mellinger magnet. If a metallic F.B. of low magnetic quality is placed in a magnetic field, the magnetic quality will improve but only to a certain extent, saturation being reached very quickly. It is for this reason that numerous applications of the magnet are unnecessary, and, in addition heat is generated in the wiring and through this the pulling power of the magnet is decreased.

Non-magnetic F.B.'s.

To tackle a non-magnetic intra-ocular F.B. is always a big responsibility, especially if the vision of the eye has not been seriously impaired at the time of the penetration. It is a question of differentiating between those that will do harm if left and those that will remain inert.

The most chemically active are copper, lead, brass and zinc. The inert are, porcelain, glass, stone, aluminium, plastics, and wood. The chemically active almost invariably lead to loss of the eye unless extracted, and for this reason risks must be taken. The chemically inert, unless of large size, are better left alone. Even if they carried in infection at the time of penetration, their removal will not affect the end result. A skiagram helps in that, stone, wood, porcelain, aluminium and most types of glass are almost non-radio opaque, whereas lead, copper, brass and iron are densely radio-opaque. But not all radio-opaque F.B.'s are chemically active, *e.g.*, gold and silver.

The localisation of a non-magnetic F.B. is very important if possible, and the operative technique is that already described up to the use of the magnet. Thereafter there are two ways of proceeding with the extraction, direct and indirect.

1. In a darkened operating theatre the eye is transilluminated through the pupil with a Sache lamp if possible, or other transilluminator, and the F.B. seen as a black or glittering point in the vitreous through the scleral incision, which has to be large, and more extensive diathermy is therefore needed.

2. Cases are recorded where the F.B. has been successfully extracted by observing it through the pupil with an ophthalmoscope and seizing it with forceps or snare inserted through a

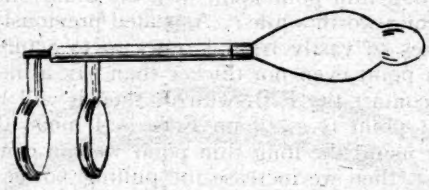


FIG. 24a.

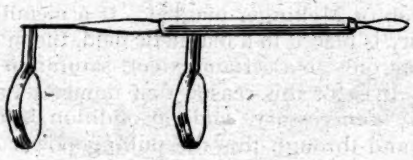


FIG. 24b.

scleral incision. With this method only monocular vision is possible with all its limitations, such as attempting to judge orientation, and considerable stirring up of the vitreous must occur in most cases. For this reason we believe the first method is the operation of choice.

For the extraction, the forceps illustrated is used (Fig. 24 a open; Fig. 24 b closed).

Summary

A new localiser and method of localisation of radio-opaque intraocular F.B.'s is described.

An improved operative technique is described in stages.

The problems of diathermy and magnetism are discussed and advice offered on how to regulate and use the diathermy apparatus to avoid complications.

A diagram of new forceps for extraction of non-magnetic F.B.'s is given.

We wish to thank Colonel A. J. Gibson, D.S.O., T.D., Officer Commanding the Hospital for granting us facilities and help in our work, and Lieut.-Colonel G. I. Scott, Adviser in Ophthalmology, M.E.F., for permission to publish the paper.

We are greatly indebted to Professor Goldberg and his Staff of the Experimental Laboratory, Tel-Aviv, for advice in solving technical problems.

Lastly, to the Staff and Workmen of 309 L.O.C. Workshops, R.E.M.E., our sincere thanks are due for the construction of the localiser and their practical advice in interpreting the design.

WAR SURGERY OF THE EYE IN FORWARD AREAS*

BY

Major E. C. ZORAB, R.A.M.C.

SURGEON TO A MOBILE OPHTHALMIC UNIT

IN ophthalmic surgery, as in general surgery great advances have been made in the facilities which are available to a man wounded in battle.

Every eye injury comes under the care of what one may call an ophthalmic team, which consists of three parts, *viz.*,

(1) A Mobile Ophthalmic Unit.

(2) A Base Ophthalmic Wing.

(3) An Ophthalmic Department in United Kingdom, perhaps St. Dunstan's.

* Received for publication, April 30, 1945.

In order to appreciate the type of work done by each part of the team, one should have a clear picture of the conditions under which work is done, and the lines of communication from battlefield to base. These conditions vary with the seasons and with the types of terrain, and have a definite bearing on the method of treating a case.

Let us follow the case of a man wounded in the eye during an attack. If it is an eye injury only, he will make his own way back to the R.A.P. If his eye wound is one of many wounds which prevent him walking he will wait until collected by stretcher bearers who will carry him back there. Here he will be seen by the R.M.O., dressed, given a hypodermic injection of morphia gr. 1/4, and started on a course of oral sulphanilamide. His next journey is by ambulance (which may be the ordinary type or Jeep, or even mule) to the A.D.S. of the Field Ambulance. Here resuscitation measures are applied if necessary and he is sent on down to the M.D.S.

This is the "Sorting Centre" and from here he will be sent either to the Advanced Surgical Centre located at an F.D.S. for priority one treatment of his general wounds, or direct to the forward C.C.S. in the Corps at which will be located the Mobile Ophthalmic Unit for that Corps. He may have other wounds requiring more immediate surgery and this will necessitate remaining at the F.D.S., but the majority of cases are fit to be evacuated to the Mobile Ophthalmic Unit before any general surgery is undertaken. Some cases, such as compound fractures of the femur, bleeding wounds, and other cases unfit to travel are operated on at the F.D.S. and sent on to the Ophthalmic Unit the following day. A few cases, such as abdominal perforations and chest wounds with haemorrhage need to be operated on at F.D.S. and remain there from ten to fourteen days. This necessitates the ophthalmic surgeon visiting the patient to assess the severity of the eye wound, possibly taking with him minimum operating equipment. The majority of cases therefore reach the Ophthalmic Unit between six or twelve hours after wounding, some twenty-four to thirty-six hours, and a few are visited perhaps twenty-four hours after wounding, but cannot be sent to any part of the ophthalmic team for ten to fourteen days or more.

The second stage of the journey through the hands of the ophthalmic team is nearly always a long one in distance but since air evacuation is usually available it is a comparatively short one in time. The fitness or otherwise for evacuation from the first to the second parts of the team therefore depends almost entirely on the accessibility of the airstrip to the forward C.C.S. Sometimes it is a matter of two or three miles over tar-mac roads, and at others fifteen to twenty miles over third-rate roads with many demolitions

and diversions. In the former case a patient can often be evacuated without harm, forty-eight hours after operation, while in the latter it may be necessary to retain him for five or six days or even more.

The third stage of the journey depends on the available space in hospital ships returning to the United Kingdom; except in the case of blind patients for whom priority can be obtained either by sea or air, for transmission direct to St. Dunstan's.

Such then is the composition of the ophthalmic team; widely separate in distance, but working closely together for the same end. Here let it be said that it is a great advantage for the forward surgeon to know who is behind him, both personally and professionally. It makes for closer team work and helps in preventing him attempting too much or too little. It also allows him to know that his mistakes will be pointed out with fair criticism, and without malice, and that helpful suggestions will be made.

There is one great disadvantage to forward surgery, and that is that the surgeon never sees the end results of the cases on which he has operated. Follow-up cards help to some extent, but are never the same thing as seeing for oneself. In addition, it is often impossible to assess the end result for a year or even more, when all the usual dangers and complications may be said to have been passed, and perhaps several further operations performed.

For these reasons one cannot judge the adequacy or correctness of one's surgery by the visual result obtained either immediately or after a few weeks. Some months later the picture may have been changed vastly—for better or for worse. Therefore any attempt to produce statistics of operative results until all the cases have been carefully followed for more than a year, is bound to be fraught with difficulty and full of fallacies. For guidance, one must rely on one's own experience of early operative results, the long term experience of other surgeons, and the comments of the surgeons at the base.

Method of working of the ophthalmic unit

The surgeon is notified by the reception clerk as an " eye case " arrives. The same is left in reception until the surgeon, accompanied by his orderly, comes to see it. Unless he happens to be operating this will be immediately, day or night. The orderly brings with him the " examination tray " containing cotton wool swabs, wet and dry; pads; flaps; bandages; adhesive plaster; cocaine; atropine; sodium penicillin, drops or ointment; glass rods; Desmarres' retractor; ophthalmoscope and binocular loupe.

The case is diagnosed, and the Field Medical Card written up and re-attached to the patient. It may be necessary to consult

with the general surgeon and the resuscitation officer, with regard to other wounds or the patient's general condition. X-rays are taken if required and the man is then transferred to the pre-operation ward to await operation, premedication having been ordered for a certain time. Unless contraindicated the patient is undressed, washed, put into pyjamas, and back on to his stretcher. When called for he is taken to the theatre, and put on the operating table, still on his stretcher.

This unit carries the full equipment of an ophthalmic operating theatre, including anaesthetic apparatus. It is preferable to have one's own theatre, but essential to have at least one's own table in a combined theatre. It is unsatisfactory to both parties for the ophthalmic surgeon to use the C.C.S. theatre for his cases, particularly if there are many general cases waiting as there usually are. It also means a lot of unnecessary carrying of instruments, magnet equipment, electric wiring, and much waiting for a vacant theatre.

The most convenient theatre, for the summer months at any rate, is the E.P.I.P. tent which is part of the equipment. As far as possible it has always been arranged for the ophthalmic operating theatre to be located within an easy stretcher carry from the general surgical theatre. If there have been only minor wounds in the rest of the patient they have been dealt with in the ophthalmic theatre, for which purpose a few extra instruments are carried. For more serious wounds the patient has been transferred, still under an anaesthetic, to the general theatre, or has had his other wounds treated first by the general surgeon and then been transferred for his eye operation.

For more than six months, I was associated at various C.C.S.'s with the advanced sections of a maxillo-facial, and a neurosurgical unit, often sharing an operating theatre and an anaesthetist. This association, which came to be widely known as " The Trinity " was most satisfactory from all points of view. It enabled all wounds occurring above the neck to be dealt with at one centre, with one anaesthetic, and, not the least important, it gave all three specialists valuable experience in other closely allied specialities. For what I learnt from this association, I shall always be grateful to Major H. V. Slemon, R.C.A.M.C., Major Murley, R.A.M.C., Major E. J. Dalling, A.D.C., and Major R. P. Harbord, R.A.M.C., the anaesthetist.

The type of anaesthesia was determined by the requirements of the particular case. This unit does not carry an anaesthetist for the very good reason that he would seldom be fully employed. In normal periods, the services of an anaesthetist can usually be borrowed for the small number of operations performed. During a battle, when an anaesthetist could be fully employed, the C.C.S.

anaesthetists are too busy. Occasionally, one was attached for temporary duty from a non-working unit, but often I had to give my own general anaesthetic—an unsatisfactory practice.

While working with the " Trinity " an anaesthetist was shared by all three units, and he frequently had three anaesthetics under supervision simultaneously. This arrangement was satisfactory only so long as the three teams were either sharing a large theatre, or were working in adjoining theatres. Nearly all jaw, face, and head cases that needed general anaesthesia needed endotracheal intubation, and could thereafter be safely left on the Oxford vapouriser under observation. Comparatively few eye cases—less than 20 per cent.—could be done under local anaesthesia partly on account of other injuries requiring general anaesthesia, and partly because having only recently been wounded in battle, most patients were not in a fit condition psychologically to undergo an operation under local anaesthesia.

It was found that the anaesthetic of choice was a continuous pentothal drip. It was given as a ½ per cent. solution in normal saline or glucose saline with an ordinary intravenous infusion set, combined with cocaine drops in the eye, morphia and hyoscine premedication; and continuous oxygen *via* an intranasal pharyngeal tube. This gave a very smooth anaesthetic with the minimum of trouble, practically no respiratory movements of the head, little or no post-anaesthetic cough or vomiting, and could be continued for as long as was required. As much as 3·5 grams of pentothal was given on occasions for long combined cases with no ill effect.

Types of cases dealt with

Injured eyes can be roughly divided into two classes—Non-repairable and Repairable.

(I) *Non-repairable.*—Under this heading are included all eyes that are so badly damaged as to be anatomically non-repairable. In every case of course there is no perception of light. Their removal is not urgent and the indications for operation at this level are:—

(*a*) When other wounds necessitate a general anaesthetic. It is as well to remove the eye at the same time to avoid the necessity of a second operation later.

(*b*) When adequate examination is not possible without general anaesthesia and the eye is then found to be non-repairable.

(*c*) When coincident laceration of lids suitable for primary suture is present. If a disorganised eye is left, the resultant discharge will militate against primary healing of lid wounds, particularly those of lid margin.

(*d*) When there is much pain, as is sometimes the case with

large uveal prolapses adhering to the lid margins, and often the case with large orbital foreign bodies.

(*e*) When panophthalmitis has already supervened.

The above constitute about 80 per cent. of all non-repairable eyes, and therefore except during excessive rush periods, very few are sent on unoperated.

The operation for non-repairable eyes has almost invariably been evisceration and excision of sclera, leaving a small frill. It would seldom be possible to do otherwise at this level, for the eyes that must be removed here are usually dirty, ragged ocular remnants, and enucleation would be difficult and have little advantage, quite apart from the danger, hypothetical or real, of meningitis. Occasionally the conjunctiva has been sutured over the stump after insertion of penicillin powder, but more often it has been left open. Reports from the base indicate that it might be possible to hasten socket healing by suturing conjunctiva in rather more cases provided they are carefully selected.

(II) *Repairable.*—Under this heading are included all cases which are anatomically repairable, whether they be—

(i) Eyes with no perception of even the brightest light;

(ii) Eyes in which mild sepsis is already present;

(iii) Eyes in which one knows that there is barely one chance in a hundred of their being of any value.

This is an extreme policy and is only justifiable because one is working as part of a team and knows that the patient will not be allowed to run any risk of sympathetic ophthalmitis. The few cases which unexpectedly retain or attain some vision, even if only perception of light, especially if they happen to be bilateral, more than justify the very many cases which later lose the eye.

It is comparatively rare to find a man who has in his whole body only one wound of one globe. The majority of cases have perhaps one eyelid and eye, one arm and one leg wounded, or some similar combination. Perhaps one eye severely and one mildly damaged. Perhaps multiple peppering of chest and face with one eye perforated and one with multiple corneal foreign bodies. It is therefore impossible to divide the cases into groups, but only the wounds. In the following description therefore it must be borne in mind that more than one of the wounds may be present in the same case.

Perforating wounds of the globe.—These are the commonest type of wounds requiring surgery, and may be divided into two groups:—

(*a*) Those produced by blast;

(*b*) Those produced by foreign bodies.

(*a*) *Produced by blast.*—This type of wound was not uncommon in air-raids particularly in cities where the blast

occurred in confined spaces. With the lessening of aerial bombardment, at any rate in the field, they have become less common, but are still occasionally seen in men who have been very close to a shell, mortar, or grenade burst, but have not actually been hit by a fragment. Only eight such eyes have been seen of which three had already had the lens and a large amount of vitreous extruded, and were therefore worthless. The ruptures all occurred in the usual site *i.e.*, nasally, and attempts were made to repair the others, but as the ruptures were mostly semi-circumferential little success was met with. Two of them retained perception of light up to a month after operation, but the end result has not been traced. As many as eight scleral sutures were used in one case. Three of the cases were bilateral.

(*b*) *Produced by foreign bodies.*—This group comprises the majority of cases operated on, and will therefore be dealt with in some detail. Slightly more than half the number (53 per cent.) had perforating wounds of the cornea or limbus, and slightly less than half (47 per cent.) had perforating wounds of sclera. In peace time corneal perforations predominate more markedly and the reason presumably is that in wartime the fragments producing these wounds are travelling at a higher speed, and therefore the lids offer less protection. It is certainly a fact that a higher percentage of cases is found in wartime with perforations of lid and globe. In this group only three cases occurred in which the injured man was wearing spectacles at the time of wounding; *i.e.*, less than 1 per cent. Since considerably more than 1 per cent. of front line troops wear spectacles it may be assumed that they afford some protection against a perforating wound of the globe even in wartime.

In dealing with these cases the principle has been to attempt to remove all foreign bodies, all prolapsed tissue, and to close all open wounds at the first opportunity. There are of course many circumstances which make it advisable to deviate from this principle, and no hard and fast rules can be laid down. Exceptions to this principle have been made in the following type of cases:—

(*a*) In which a foreign body, possibly magnetic, is lying in a collapsed anterior chamber which is not reforming, and the lens is as yet undamaged. Any attempt to extract the foreign body will assuredly damage the lens. The better procedure is to close the wound with a conjunctival flap and wait till the anterior chamber reforms.

(*b*) In which there is a foreign body in the lens, and a clean self-closing wound of entry. Whether magnetic or not, the foreign body is better left until the eye settles down, when it can be removed while the traumatic cataract is being dealt with.

(*c*) In which the wound is self-closing, there is no prolapse,

and it is doubtful whether the foreign body is intra- or extra-ocular. Such cases can travel without harm and can well wait until they reach base for accurate localisation.

(*d*) The above are purely ophthalmic considerations. There must also be considered the general condition of the patient and his other wounds, particularly penetrating wounds of chest or head, severe burns, and cases which have already had one operation during the day. The moving of such cases to and from an operating theatre and possibly the giving of a general anaesthetic might cause one to sacrifice a life in order possibly to save an eye.

For those cases in which operation is to be undertaken the pre-operative measures have already been described.

Operative measures

Preparation of the field of operation consists in a good wash with soap and water followed by saline, cutting of the eye-lashes, and instillation of cocaine drops, whether or not a general anaesthetic is being given. In some cases, particularly mine injuries with the whole face spattered and burnt, it is advisable to shave the eyebrows, moustache if any, and as much of the scalp as is affected. No skin antiseptics are used.

Scleral perforating wounds

(*a*) *Through and through.*—It is rare for both entrance and exit wounds to be visible although a few such cases have been seen. More usually, the position of the exit wound is unknown, and its situation can only be guessed at from the position of the foreign body in X-rays.

No attempt is made to remove the foreign body, and unless both wounds are exposed or visible no attempt is made to repair the exit wound. The conjunctiva is dissected away from the entrance wound in such a way that it will be easy to pull it back as a flap over the scleral wound. (Diagram 1.) The edges of the scleral wound are cleaned and trimmed, usually with a knife which is easier than scissors, all prolapsed uveal tissue and vitreous

abscissed, and the wound drawn together with scleral sutures. For this purpose, there is no doubt that Stallard's corneal needles on number 00 silk by "Mersutures," are by far the easiest to insert,

particularly as the eye is already soft. For linear wounds an attempt is made to insert the sutures in the form of a square or mattress stitch. (Diagram 2.) When the wound is circular with ragged edges this is not always feasible, and the wound must be closed however possible with the minimum wrinkling of the sclera. The conjunctiva is then drawn over the scleral wound in such a way that the two suture lines do not coincide. (Diagram 3.)

The foreign body which strikes the eye tangentially, lacerating the sclera is only a limiting example of a through and through wound, and presents no different problems.

(*b*) *With retained foreign body.*—In the majority of cases it is not possible to see the foreign body ophthalmoscopically on account of vitreous haemorrhage. However, with an open wound of the sclera the exact position of the foreign body is not of great importance since an attempt to remove it via the wound of entry will be made wherever it is. Less harm will result to the eye by removing it via the entry wound than by trying to localise it by the Skeoch ring method, close the entry wound, and open the sclera in another place, all of which would entail extra manipulation in an already severely damaged and soft eye. It must here be stressed that this applies only so long as the entry wound is still open.

When attempting to remove the foreign body it is advisable to expose and clean the scleral wound, and insert the necessary sutures before abscissing the prolapse or bringing the magnet up to the wound. It sometimes happens that abscission of prolapse or extraction of a foreign body is followed by a flow of vitreous, and if the sutures are not already in place their insertion at this stage will certainly cause more vitreous to be lost.

My former practice was to try the Livingstone hand magnet in every case before trying the Haab magnet, but so many cases were found in which the former gave no response, and the latter extracted the foreign body without difficulty, that I have discarded the former. The Haab magnet is counterbalanced on a swivelling stand so that it can be manipulated into any position with ease and accuracy. In addition, a foot switch is far more convenient than a thumb button, as on the former. No attempt is made to cauterise the wound edges or the neighbouring choroid, partly because no diathermy apparatus was available, but chiefly because the trauma of the perforation seems to produce an adequate scar, and although retinal detachments do occur it is not thought that they would be avoided by diathermising an area around the wound in a soft eye. Again, these remarks apply to the open wound case and not to the set operation of posterior route extraction of foreign body.

Corneal and limbal perforating wounds

(*a*) *Without retained foreign body.*—These are usually caused by a fragment striking tangentially. This type of case is very similar to the peacetime injury by the "screw driver that slipped" or the knife blade accident. It presents no separate problems, and repair is by abscission of prolapsed tissue, and wound closure by a conjunctival flap.

(*b*) *With retained foreign body.*—When a single limbal perforation is present with a hole in the iris and little or no damage to the lens, it is frequently possible to draw the foreign body back along its track if it is magnetic. It can perhaps be removed by the entry wound or at least brought into the anterior chamber and removed by a keratome section. This method may result in a small anterior synechia, but this can be divided later.

When a single perforation is slightly nearer to the centre, there will probably be a hole in the iris or a cut in the pupil margin, a prolapse of iris and lens capsule, a completely opaque lens, and possibly the anterior chamber will be absent. In these cases extraction *via* entry wound or anterior route is not advisable and primary operative measures should be confined to abscission of any prolapse, and closure of the entry wound to ensure reformation of the anterior chamber. The foreign body should be left for posterior route extraction later, after X-ray localisation.

If a single perforation occurs in the pupillary area, damaging the lens, the method of approach will depend on :—

(1) The condition of the anterior chamber;
(2) The state of swelling of the lens, and
(3) The situation of the foreign body on X-rays.

Absence of the anterior chamber is a definite contraindication to anterior route attempt. If the anterior chamber is full of soft lens matter and the foreign body is somewhere amongst it, as shewn by X-ray, it is justifiable to remove it anteriorly. If the foreign body is shewn to be in the posterior two thirds of the globe it should be removed by the posterior route.

In those cases where there is no swelling of the lens, the anterior chamber is present, the pupil can be well dilated, and the foreign body can be seen or localised somewhere behind the lens, the method of extraction depends on the personal choice of the surgeon. Details of the classical anterior and posterior route extractions are too well known to be included here, but there is one point worth mentioning. In making the keratome section for the anterior route extraction of foreign body, it should be commenced two or three millimetres inside the limbus. The inner lip of the incision will then be about four millimetres from the angle of the anterior chamber. This will make it easier to

avoid prolapse of iris and/or loss of aqueous. Should the anterior chamber be lost during the making of the incision no attempt should be made to remove the foreign body until it has reformed or been refilled.

Lastly, there are the cases with multiple corneal perforations. Usually there is also prolapse of iris, lens matter and vitreous, and perhaps gravel, sand, or clay soil driven right through the cornea into the anterior chamber. They are almost always mine injuries, frequently bilateral, and the results are disappointing. In spite of such gross damage to the anterior section of the eye they frequently have perception of light with accurate projection. I have tried doing the minimum to the eye and also doing the maximum. The minimum consists in washing the eye out, putting in atropine, penicillin, and a pad and bandage and leaving it to recover or not, as best it can. The maximum consists in abscissing all prolapse, removing foreign bodies or debris from the anterior chamber with a scoop, and from the cornea with a needle, refilling the anterior chamber with penicillin and covering the whole eye with a conjunctival flap. My impression is that there is very little to choose between the results of the two methods, so that a middle course probably gives the eye the best chance. A number of such cases have settled down without infection, even with visible particles of stone in the anterior chamber.

There are two subjects about which a word must be said, namely, conjunctival flaps and penicillin.

Conjunctival flaps

There are very few cases in which a complete purse-string conjunctival cover is necessary, and it has the great disadvantage that the condition of the eye underneath it cannot be seen. This disadvantage is bad enough when the case is under the care of one surgeon, but when a case is being passed from one surgeon to another it becomes even worse. It is therefore better to avoid it whenever a visor flap will serve the same purpose, as it usually will. In cutting the flap, care should be taken to make it as thin as possible. Not only is a thin flap more elastic, but it does not tend to adhere to the wound so much as a full thickness flap. It frequently happens—particularly in mine injuries—that the conjunctiva is damaged in several places. When the flap is drawn over the corneal defect it can usually be arranged that an intact piece of conjunctiva covers the actual defect, and there is no need to mend the holes.

I have found that when dissecting a flap the use of a sharp scalpel or Bard Parker blade, instead of scissors, not only facilitates the procedure; but enables one to obtain slightly more conjunctiva near the corneal margin.

Penicillin

The use of penicillin in ocular injuries is still in the experimental stage and it is not possible as yet to give any statistical results proving its value. There are, however, some indications which are worth mentioning.

(1) Since January, 1944, penicillin sodium drops or cream have been used as routine at the end of every operation, and at every post-operative dressing. Prior to January, 1944, penicillin was not used. In the pre-penicillin era six cases out of 132 (4·5 per cent.) developed panophthalmitis in the first few days after operation. Since January, 1944, 3 cases out of 214 (1·4 per cent.) have developed panophthalmitis in the first few days.

(2) It has been found that the stickiness and discharge usually present at post-operative dressings has been minimal or absent, since the use of penicillin.

(3) Sodium penicillin solution (1,000 units per c.c.) has been introduced into the anterior chamber during operation in 20 cases, most of which have been mine wounds with dirt and debris in the anterior chamber. It is not considered that this has had any markedly favourable effect on the progress of the case. In 6 cases sodium penicillin, minims 5 (1,000 units per c.c.) has been injected into the vitreous along the suspected course of stone intra-ocular foreign bodies. In three of these cases, panophthalmitis supervened as expected. Of the other three, one gradually developed endophthalmitis, but the other two retained an eye with accurate projection of light up to a fortnight, and a month respectively. Since they were both civilians further follow up was impossible.

My impression so far therefore is that penicillin is of considerable value as routine in the conjunctival sac, of some value as a vitreous injection, but of no value as an anterior chamber wash out or injection. It has been proved experimentally that it diffuses readily throughout the vitreous by direct injection, but not at all by intramuscular injection. Sub-conjunctival injection is being tried, throughout this theatre.

Non-perforating wounds of the globe

(1) *Corneal foreign bodies.*—These vary considerably in size, number, and depth. It is often impossible to remove more than a few at one session. Some will work their own way out. Some will remain there always without causing any trouble. The ones which should receive attention first are those projecting above the level of the cornea, and those in the pupillary area of the cornea, where residual scarring will cause most disability.

(2) *Scleral foreign bodies.*—Although these *per se* are not

urgent or dangerous it is frequently difficult to tell whether they are perforating or not. If there is any doubt the track should be explored and the sclera examined.

Wounds of soft tissue

Lid Wounds.—Provided that there is no tissue loss, all but the very dirtiest of lid wounds can be sutured with the aid of penicillin powder. It is surprising how often a lid wound which appears dirty will heal by first intention when thoroughly washed and sprayed with penicillin powder. It is a distinct advantage to suture lid margin wounds straight away whenever possible, for they heal with less of a notch than if left till later.

If there is any loss of lid tissue, either skin or deeper tissue it is better to clean them thoroughly, excise nothing at all, spray with penicillin, and send on to a Maxillo-facial unit. It is sometimes advisable in extensive wounds to put in two or three temporary sutures, leaving long ends, merely to hold the parts in approximately the right position.

Compound fractures around the orbit

It is quite common for the missile which destroys an eye to produce a fracture of the orbital walls, perhaps involving one of the air sinuses.

The foreign body is often firmly embedded in bone, and unless it is easily accessible it is better to leave it alone and confine one's activity to toilet of the wound, removing only such soft tissue as is non-viable and only such bone chips as have no periosteal attachment. One of the commonest cases is that of a foreign body passing through the lid, eye and floor of orbit, and coming to rest in the antrum. Having removed the eye it is worth while putting the magnet up to the defect in the orbital floor, when, in quite a number of cases the foreign body is easily removed. Very few cases develop an empyema of the antrum, and it is possible that sulphanilamide is responsible for this.

Only two cases have been seen in which an orbital foreign body was considered to require immediate removal. In both cases the eye was present and was not perforated, and recovery of function was expected. The foreign bodies were large and were causing displacement of the eye, limitation of movement, and pain. The first one was a shell fragment, about the size of a lump of sugar, and had entered through the cheek, on the opposite side. It was lying in the upper outer part of the orbit and was removed *via* conjunctiva and Tenon's capsule. The second was a Tommy gun bullet which had entered the external canthus, and become embedded in the centre of the floor of the orbit with the round

nose uppermost. This was removed by the wound of entry after canthotomy and medial retraction of the orbital contents.

Fractures of the upper part of the orbit, so severe as to expose or open the dura are better dealt with by the Neurosurgical unit.

General considerations

One of the most surprising facts is the very low incidence of sepsis either as panophthalmitis, hypopyon ulcer, or cellulitis. In spite of the dirty conditions of the wounds, and the far from ideal conditions of asepsis obtaining in a field operating theatre, sepsis was extremely rare.

In my opinion the reasons for this are:—

(1) The healthy state of the front line troops;
(2) The routine administration of sulphanilamide at the earliest opportunity to all wounded men;
(3) The routine use of penicillin in all eye injuries;
(4) The minimum number of changes of dressings.

One of the chief differences between the wartime intra-ocular foreign body and the peace time one is the almost constant presence of vitreous haemorrhage in the former. This may be caused by the higher velocity of the fragment, or the blast that always accompanies it. It adds to the severity of the wound and consequently lessens the chance of recovery of good vision.

The statistics given below will give a good idea of the type of cases and their relative frequency. No attempt is made to assess results.

440 consecutive cases of battle casualty eyes requiring major operations October, 1943, to October, 1944.

(1) Missile accounting for wound.

		per cent.
Shell	102	= 30
Mine	68	= 20
Mortar	57	= 16·7
Grenade	38	= 11·1
Unknown Missile	30	= 8·8
Bullet	16	= 4·7
Booby Trap	15	= 4·4
Aerial bomb	7	= 2
Hammer & chisel	6	= 1·8

(2) Eye irreparably damaged and removed 59 = 28·7 per cent.
(3) Number of cases in which brain was involved 20 = 6 per cent.
(4) Number of cases in which accessory sinuses were involved 40 = 12 per cent.
(5) Number of eyes in which panophthalmitis supervened a few days after operation 9 = 2·5 per cent.

(6) Of 208 repairable perforating wounds: scleral 97 = 47 per cent.; limbal and corneal 109 = 53 per cent.

(7) Of these 208 eyes the number with probably no intra-ocular foreign body (including through and through wounds) 41 = 20 per cent.

(8) Of these 208 eyes the number probably with intra-ocular foreign body 167 = 80 per cent.

(9) Number of eyes in which intra-ocular foreign body was removed by magnet 72 = 43 per cent.
(*a*) Anterior route 12 = 16·7 per cent.; (*b*) Posterior route 10 = 14·4 per cent.; (*c*) Wound of entry 50 = 69 per cent.

(10) Number of eyes in which intra-ocular foreign body was removed by means other than magnet 18 = 10·8 per cent.

(11) Number of eyes in which probable intra-ocular foreign body was not removed 77 = 46 per cent.

(12) Number of cases in which intra-ocular foreign body was present, but in which no attempt at removal was advisable 6 = 3·6 per cent.

Summary

(1) A description is given of the working of a Mobile Ophthalmic Unit in the Mediterranean Theatre of War.

(2) Surgical procedures adopted in dealing with various eye injuries are outlined.

(3) An analysis of the major operations performed during a year in the forward areas is detailed, showing the relative frequency of various types of eye injury.

In conclusion, I would like to thank, first, my sergeant and four men, without whose tireless efforts, cheerfulness, and close co-operation, both while working and while moving, little could have been accomplished; secondly, the Adviser in Ophthalmology A.F.H.Q., for his continuous support in keeping this unit at all times fully equipped with everything that could be required, and for his comments and helpful suggestions on cases sent back; thirdly, a number of C.C.S. Commanders who spared no pains to accommodate what must have been to them a rather troublesome attached unit; and finally the D.M.S., A.F.H.Q., for his interest in the unit, and for permission to publish this paper.

Abbreviations.

C.C.S. = Casualty clearing station.
A.D.S. = Advanced dressing station.
M.D.S. = Main dressing station.
F.D.S. = Field dressing station.
R.A.P. = Regimental Aid Post.
R.M.O. = Regimental Medical Officer.

OPHTHALMOLOGY IN THE B.N.A. & C.M. FORCES*

BY

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THIS account of the ophthalmic services of the British Forces in the Western Mediterranean Theatre is written for the information of senior colleagues at home who have shown constant interest, and as a tribute to the work of their junior colleagues abroad who have provided the material for it. The period covered extends from November, 1942, to November, 1944, and includes the campaigns in North Africa, Sicily and Italy.

The campaign in North Africa—administration

When the Allied Armies in the Autumn of 1942 descended on North Africa and began their advance eastwards towards Tunis, the general plan for the care of ophthalmic cases was based on formal lines, namely, with an ophthalmologist as a member of the staff of General Hospitals having 600 beds or over. By early January, the First Army had become embroiled in the hills of the Tunis-Algerian frontier, and all major ports along the North African coast had been occupied. The campaign, then, at this time fell naturally into three parts of military administration.

(1) *First Army Area.*—This was the forward area which contained field ambulances, C.C.S.s, and small and medium general hospitals. At this time there were about three ophthalmologists in the area at 600 bed general hospitals and the main function of all medical units here was the early collection, care, and speedy evacuation of casualties.

(2) *Lines of Communication Area.*—This area involved a large expanse of territory in N. Africa from the eastern Algerian Frontier back to the coast at Algiers, and it included large general hospitals at key ports and strategic railway positions. Such hospitals each carried an ophthalmologist and acted both as a reservoir to relieve the pressure of beds in the Forward Area, and as a place for more prolonged treatment to avoid congestion at Base.

(3) *Base Area.*—In the base area were concentrated the largest of the general hospitals ranging over 2,000 beds: from these evacuation to the U.K. took place. The D.M.S. at this time at Allied Force Headquarters was Major-General Sir Ernest Cowell, K.B.E., and the task of making arrangements for the care of all surgical cases including ophthalmic cases was in the hands of Brigadier John Weddell, C.B.E.; it was a task of no small magnitude.

* Received for publication, May 12, 1945.

The main base medical stores for the campaign were located in Algiers. All general hospitals had arrived in North Africa with full ordinary ophthalmic equipment, but there was a shortage of such items as giant magnets, diathermies, and slit-lamps.

In the base and L. of C. areas this conventional arrangement for ophthalmic care functioned well and cases were distributed to general hospitals in large or small numbers so that ophthalmic surgeons were busy or slack as the case might be. But in the Army area where mobility of units was the rule, it was soon realised by Major E. C. Zorab, R.A.M.C., that the ophthalmic services also must be more mobile. Accordingly, therefore, he improvised a mobile ophthalmic unit which consisted of a surgeon and surgical equipment, a sergeant optician and optical equipment and a clerk. This unit toured the countryside in a borrowed vehicle amongst units of the First Army and with great success dealt with their eye emergencies and provided the immediate supply and repair of spectacles.

Since at this time, as the next Field Optical Section was hundreds of miles away at Algiers, it will be realised how valuable was the work done by this unit in saving man-power and how well deserved was the " Mention in Dispatches " which Major Zorab subsequently received.

Later, as more hospitals and stores arrived in the Theatre, the situation became better, and by the time of the fall of Tunis, Field Optical Sections had been established in each of the three areas and delay in the supply of spectacles was much reduced. Moreover, such special stores as slit-lamps, diathermies and electromagnets had now become available, in spite of shipping losses: it will be recalled that at this period the Mediterranean was not yet open.

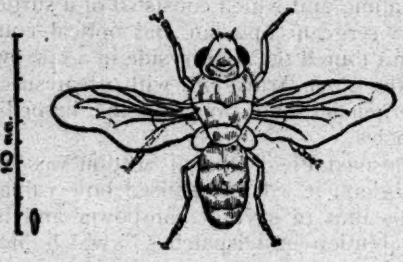
Clinical Ophthalmology in North Africa

Apart from the usual ocular diseases and the accidents incidental to both military and civil practice, certain interesting conditions related to the terrain and the sub-tropical climate of North Africa, as well as battle casualties from all kinds of missiles were encountered.

1. *Ocular Myiasis.*—Several cases of ocular myiasis were reported in British and American forces in N. Africa. This disease was first described in 1901 by the Sergents and is due to the implantation in the conjunctival sacs of the larvae of the oestrus ovis (bot fly). Normally these larvae at all stages of evolution infest the frontal sinuses of sheep but only the first stage is found in man, and it is common to find that where there is an abundance of sheep as in the upland districts man is not attacked.

Almost all the military cases were reported from coastal districts.

The larvae are discharged by the fly directly into the conjunctival sac either by contact or in flight. They attach themselves to the conjunctiva by their tiny hooklets and wriggle along by alternating contractions and expansions of their bodies. Considerable conjunctival irritation and inflammation are caused by their presence as there may be up to 2 or 3 score in the conjunctival sac. The instillation of cocaine paralyses the parasites which thereupon lose their grip and may easily be removed: the cessation of their mobility is sudden and very striking. Special care should be taken to reach and clear the retro-tarsal spaces and folds.



Oestrus Ovis and Larva to scale.

Larva showing hooklets.

2. *Follicular Conjunctivitis.*—Apart from the ordinary juvenile type a form of mild follicular conjunctivitis with marked injection of the bulbar conjunctiva also is seen in sand-fly fever; in the early stages of this disease photophobia is a feature.

3. *Ophthalmia Nodosa.*—Ophthalmia nodosa was reported by Major B. Gluck, R.A.M.C., in Tunisia and was due to the implantation in the conjunctiva of the barbed hairs of the common cactus.

4. *Trachoma.*—Trachoma has not occurred as a new disease in British troops, but it was of frequent occurrence amongst Sicilian prisoners of war. Military ophthalmologists adopted the procedure of everting the upper lids of all coloured troops and prisoners of war as a routine measure, and for treatment, the expression of follicles, copper applications and full sulphonamide therapy were employed.

5. *Dendritic Keratitis.*—Dendritic keratitis has been a serious menace throughout the campaign and in North Africa was a cause of much prolonged convalescence. It is non-specific in origin and may occur in all types of high pyrexia such as from malaria and infective hepatitis. Four stages have come to be recognised, (*a*) Stage of infiltration in which the zone of future ulceration is clearly marked but as yet there is no stain with fluorescein and no loss of epithelium; (*b*) simple ulceration of this zone; (*c*) severe

ulceration with much para-corneal infiltration and secondary infection; (*d*) residual stage of scar formation and vascularization where there are deep fascicular formations of blood vessels and indolence of the epithelium. A prolonged course of convalescence is nowadays prevented by appreciation that the virus is intracellular and that treatment must destroy cellular structure if it is to be efficient. Consequently, our present mode of treatment consists in breaking down the track of the ulceration by vigorous curettage at the earliest possible moment, and to employ thereafter chemical cauterization by spirit, iodine, or carbolic acid. For the fourth stage of adventitious vascularization strip and cautery peritomy and median tarsorraphy have given valuable assistance in shortening hospitalisation.

6. *Battle Casualties.*—Mortar and shell fragments accounted for the majority of these casualties in North Africa. For penetrating wounds of the globe, magnet applications, excision of prolapsed uveal tissue and the application of vizor conjunctival flaps were routine measures. It was quickly realised that the subjective negative reaction of a patient to magnet application was no guide to the presence of a magnetizable intra-ocular foreign body since time and again such foreign bodies have been seen to leap to the magnet although the patient experienced no sensation of traction. All wounds were treated also with sulphanilamide powder.

The treatment of sockets received special attention. Firm vaseline packs were thoroughly discouraged but the elevation of the upper lid by straps of adhesive plaster so as to allow air to circulate within the socket represented an advance in ophthalmic treatment. It was also recognised later that it was essential in the early stages where lid and orbit were wounded to separate the raw surfaces by a strip of vaseline gauze else otherwise lid and socket became firmly adherent by the time the case reached a base hospital.

Therapeutic measures also in fashion were oral sulphonamides, mydricaine, liquor tinctorium for seborrhoeic blepharitis and protein shock by the injection of intravenous T.A.B. vaccine for hypopyon and infection. The routine treatment of lid wounds and burns at this stage was to frost them with powdered suphanilamide followed by a covering of vaseline gauze or tulle gras.

The campaign in Sicily and Italy

Administration.—After the fall of Tunis, the First Army was disbanded and some of its divisions were incorporated into the Eighth Army. In the medical services also there was considerable rearrangement. With the Eighth Army came two mobile ophthalmic units each consisting of a surgeon, optician, operating

room orderly, clerk and two drivers. Their vehicles were two 3-ton vans, one of which was equipped as a consulting room, and the other as an optical workshop complete with generator.

The Middle East Hospitals reached the Central Mediterranean Theatre impoverished in supplies and personnel, a situation which was to be expected as a result of shipping difficulties and the long desert campaign. These deficiencies, however, were soon remedied, and for the forthcoming campaign in Italy, ophthalmic resources were adequate if not generous.

The enormous expansion of the forces in the theatre resulted in increased problems of administration and as a result, in common with other specialities, an Adviser in Ophthalmology was appointed.

After a survey of existing resources at that time, the following points of policy were decided:—

(1) To position ophthalmic and optical services as far forwards as possible—namely at C.C.S. level. This was a local implementation of War Office policy which had made provision for mobile ophthalmic units as Corps allotments, and aimed at early specialist treatment and avoidance of evacuation for spectacles.

With expert ophthalmologists and skilled opticians so far forwards wounds of the eye received the best possible attention at the earliest stage, and spectacles were dispensed with but little loss of man hours or transport time.

The motto of spectacles "Whilst you wait" and "Wherever you wait" has been truly honoured by the optical teams of the C.M.F. Even at Anzio whilst under constant shellfire, S/ Sgt. Burns and Pte. Leckie, R.A.M.C., prevented the evacuation of many scores of men by providing them with renewed or repaired spectacles on the spot. It is a little difficult to imagine spectacles as a forward commitment, but experience has amply proved this to be the case.

(2) To fuse the ophthalmic departments of several adjacent general hospitals into one Base Ophthalmic Wing, with a senior specialist as chief and other specialists as his assistants. Such a wing has 60-200 beds and here also is located trained nursing staff, optical facilities and special equipment such as diathermy, etc. To one of these Base Ophthalmic Wings has now been added an ophthalmic artist, a school of instruction, and a welfare department run by a worker from St. Dunstan's.

(3) To pay special attention to raising the standard of ophthalmic nursing in the Army and to this end special courses and demonstrations are held. An ophthalmic sister in the army is expected to be able to supervise the administration of an ophthalmic ward and to carry out all theatre duties. She must also have a detailed knowledge of ophthalmic equipment and instruments and

be able to carry out such procedures as silvering the conjunctiva, syringing lacrimal ducts, tonometry, mydricaine injections, etc., and to have a working knowledge of the use of the perimeter and ophthalmoscope. A Memorandum on Ophthalmic Nursing, A.F.H.Q. has been published.

Every Base Ophthalmic Wing in the C.M.F. has now two or more such skilled sisters according to their size.

(4) To centralise ophthalmic stores and equipment so that there is the minimum delay in supply, Q.M.S. Smith, R.A.M.C., as senior optician, is responsible for this duty and distributes the supplies which the Consulting Ophthalmologist to the Army has always directed without stint to this Force. As a result, complaints of delay have been negligible.

(5) To educate junior medical officers in the preliminary care of eye cases. For this purpose, a small memorandum was published as follows :—

Memorandum of Ophthalmology

"The Preliminary Care of Ophthalmic Cases"

The following notes are issued for the guidance of Medical Officers in the care of their ophthalmic cases.

(A) Medical Officers are expected to retain and treat cases of :

(1) Simple conjunctival catarrh and conjunctivitis;
(2) Styes;
(3) Superficial foreign bodies in the eye;
(4) Acute abscess of Meibomian gland;
(5) Non-infected corneal abrasions;
(6) Superficial burns, wounds and abrasions of lids.

(B) Medical Officers are expected to refer to the ophthalmic specialist cases of :

(1) Severe injuries and burns of lids and/or eyes;
(2) Difficulty in diagnosis; aggravation of symptoms and delayed response to treatment;
(3) Defects of vision from any cause;
(4) Suspected error of refraction;
(5) Chronic blepharitis;
(6) Corneal ulcers, infected corneal abrasions and iritis, etc.

(C) Cases referred should have :

(1) A.B.64 Part I;
(2) Old spectacles (if any);
(3) Haversack rations;
(4) Appointments—unless emergencies;
(5) Relevant notes on AFB 256 or in lieu thereof;
(6) If (*a*) accurate prescription is in A.B.64; (*b*) spectacles are less than two years old; (*c*) spectacles are comfortable, the M.O. should send an AF.I 1240 in duplicate to the nearest optical unit or ophthalmic specialist.

General instructions

(1) Always tell the ophthalmic patients what you are going to do—they are often apprehensive.

(2) Use the best illumination for inspecting an eye; mistakes in ophthalmology are generally of omission rather than commission.

(3) Look before touching; you may miss an artificial eye or squint; inspect lashes and lids, etc., in a systematic manner from before backwards, and handle the lids gently at all times.

(4) In cases of lid spasm reassure the patient, instruct him to relax and to open both eyes. Never force the lids open.

(5) Use care in instilling oculets; severe corneal abrasions have been caused by rough insertion.

(6) When instilling drops, instruct the patient to open both eyes and look upwards. Warn him and then run the drops in gently on to the conjunctiva. Do not drop them on the cornea from a height.

(7) Test the temperature of all lotions on the back of the hand before washing out an eye. Wash out eyes only if there is something to wash out, *i.e.*, discharge and not merely for redness. Never tie up a discharging eye.

(8) Except in cases of severe injury, corneal abrasions or ulcer, it is rarely necessary to tie up an eye; flaps or dark spectacles are preferable. When in doubt use a flap.

(9) Watch for sulphonamide reactions of the face.

(10) Ophthalmic specialists are always ready to help and they are aware of the limited instruction in ophthalmology which most medical officers have received.

Special instructions

(A) *Chronic Blepharitis*. If recurrent or severe, should be graded to A.4 or E.

(1) Cut lashes with vaseline scissors.
(2) Hot spoon baths and expression of pus from lash follicles.
(3) 1 per cent. silver nitrate paint to conjunctiva.
(4) Ung. or liq tinctorium is applied to lid margin: penicillin cream.
(5) Daily spirit shampoos of scalp and eyebrows.
(6) Frequent general hot baths with skin friction.
(7) Low fat diet—saline laxatives; vitamin therapy.
(8) Ung. Hyd. Ox. Flav is frequently irritant.

(B) *Stye*.

(1) Hot spoon baths.
(2) Extraction of lash; expression of pus.
(3) If multiple or recurrent, refer for investigation.
(4) No eye covering.

(C) *Meibomian Cyst.*

(1) Acute—hot spoon baths and expression—no eye pad.
(2) Chronic—refer for investigation, incision and curettage (O.P.).

(D) *Conjunctival Catarrh.*—Denoted by general redness of the eyes with no pain or sticking of the lids.

(1) Remove cause such as dust irritation, sun or smoke.
(2) Refer for investigation.

(E) *Conjunctivitis.*—Denoted by sticking of the lids every morning.

(1) Two hourly irrigations with lotio normal saline or weak tea followed by 1/2000 flavine drops.
(2) Application of 1 per cent. silver nitrate paint to the conjunctiva.
(3) Cut lashes.
(4) Atropine if there is likely corneal involvement.
(5) Smear vaseline on lid margins at night.
(6) No spoon baths and no pads.
(7) Use flaps or tinted spectacles instead.
(8) If purulent, isolate or refer for investigation.
(9) Persistent conjunctivitis, especially in Italian Ps.O.W. suggests trachoma.

(F) *Corneal Foreign Body.*

(1) Attempt gentle removal by cotton wool wisp or clean handkerchief, followed by saline irrigation.
(2) If unsuccessful instil 4 per cent. cocaine and use sterile darning needle or spud.
(3) Tie up until next day.
(4) If unsuccessful removal or unduly red next day, instil atropine, tie up and refer.

(G) *Corneal Ulcer.*

(1) Four hourly spoon baths.
(2) Atropine 1 per cent.
(3) If lids do not stick, tie up and do not wash out.
(4) If lids stick, paint conjunctiva with 1 per cent. silver nitrate; use irrigation and a flap, and cut lashes.
(5) If no improvement in 24 hours, refer.

(H) *Corneal Abrasions.*—Easily diagnosed by bright green stain after fluorescein.

(1) After small abrasions by twig or finger nail tie up the eye overnight.
(2) For large or infected abrasions, instil atropine, tie up and refer.

(I) *Injury.*

(1) Look before touching. Advise patient to open both eyes and not to squeeze lids.

(2) Never force open lids in injuries of the globe—the globe may be ruptured underneath.
(3) Always instil atropine, tie up one or both eyes and refer.
(4) Always refer cases of a foreign body in the eye received whilst using a hammer and chisel.
(5) Always refer cases of penetrating wounds indicated by iris prolapse and pupil irregularity; tie up firmly.
(6) Give aspirin or morphia for the pain.
(7) Use pulv. sulphanilamide for open lid wounds.

(J) *Burns.*
(1) Instil cocaine if there is severe lid spasm.
(2) Wash out thoroughly with warm normal saline irrigations.
(3) Paroleine or vaseline is soothing.
(4) For severe cases instil atropine; tie up and refer. Pulv. sulphanilamide to lid burns.
(5) No covering is necessary for mild cases.

(K) *Sockets.*
(1) Inspect artificial eyes for roughness of edges or loss of enamel. Replacements are available in good supply.
(2) Infected sockets should be painted with 1 per cent. silver nitrate and irrigated with normal saline lotion; cut lashes.
(3) Sockets should not be tied up; use a flap.

Unit requirements

Drugs.
(1) Cocaine 2 per cent. to 4 per cent. or oculets.
(2) Paint 1 per cent. silver nitrate in dark glass bottle.
(3) Lotio normal saline.
(4) Atropine 1 per cent. or oculets.
(5) Fluorescein 2 per cent. or oculets.
(6) Paroleine, castor oil or vaseline.
(7) Brilliant green 1 per cent.—Gentian violet 1 per cent. paint or ointment.

Appliances.
(1) Wooden jam spoons (unit carpenter).
(2) Eye droppers or cotton-wool pledgets.
(3) Sterile darning needle or spud.
(4) Round 50 cigarette tin—for irrigation.
(5) Stick applicators (spills).

Dressings.
(1) Lint flaps.
(2) Pads.
(3) Strapping adhesive ½ inch.
(4) Cotton wool.
(5) Bandages 2 inch.

The object of this publication was to stimulate interest and to ensure proper care at the earliest possible moment.

(6) To establish welfare arrangements for the care of the totally blind. Close co-operation has always been maintained with the authorities at St. Dunstan's and a special welfare department has been formed at Naples. Blind patients visit the opera and concerts weekly whilst awaiting evacuation.

In present hostilities then the usual course of a soldier with an eye wound is to be transported by the field ambulance of his division to a Main Dressing Station and thence to a C.C.S. where a Mobile Ophthalmic Unit is attached. There, the eye condition is dealt with probably by magnet extraction of the foreign body, excision of prolapses and the application of a conjunctival flap and penicillin so that the eye is made " travel safe " within an hour or two after the wound has been received. From the Mobile Ophthalmic Unit the patient, specially labelled as an ophthalmic case, is transported, often by air, to a Base Ophthalmic Wing where conditions not far short of ideal are maintained. Most Wings are located in modern hospital buildings and there is little need for improvisation.

FIG. 1.

Livingstone hand electro-magnet.

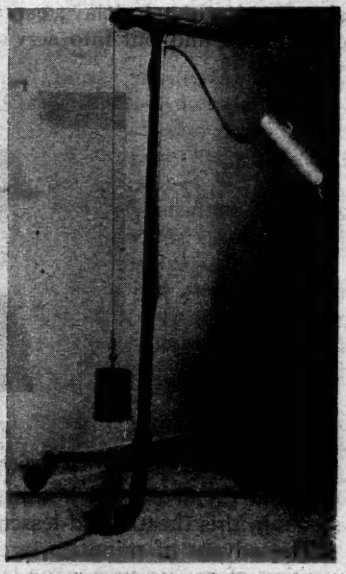


FIG. 2.

The army portable giant magnet stand, C.M.F. type.

(7) *Research.*—An active theatre of operations is hardly conducive to academic research but necessity has as ever been the mother of invention. In Tunisia the shortage of hand electro-magnets stimulated Capt. Livingstone, R.A.M.C., to produce from bits of a Sherman tank and a Daimler Scout car a small electro-magnet which has proved of great value and has since been adopted by the War Office. (Fig.1.)

A local design for suspending the Army giant magnet has also been evolved. This is of the gallows pattern with wire and pulley suspension, and " finger light " adjustment. (Fig. 2.) One of the happy features of this campaign has been the close collaboration of R.E.M.E. and the R.A.M.C. From all sides one hears of the willing help given by R.E.M.E. and the skilled technicians of that Corps. For ophthalmologists they have constructed such things as giant magnet stands, magnets, Perspex globes and electric eye warmers, etc.

So successful has this collaboration proved that a special surgical workshop, staffed by R.E.M.E. craftsmen, has been set up and there is practically no surgical instrument which cannot be made or repaired there.

Delicate ophthalmic scissors and knives are now replated and sharpened without delay; captured ophthalmic equipment is reconditioned and put into service and various spares are speedily

FIG. 3.

Anti-mine perspex visor.

distributed, all of which contributes to the healthy situation of stores in this theatre and lessens the strain on home production.

The advent of mine warfare directed interest towards the prevention of penetrating wounds and an anti-mine visor of Perspex has been devised and is in use. (Fig. 3.)

Penicillin in its relation to ophthalmology has been investigated by ophthalmologists of this force, and their conclusions are given later.

Clinical Ophthalmology in Sicily and Italy

The campaign in Sicily and Italy found ophthalmologists well prepared for their task for they had been well schooled in the treatment of battle casualties both in the Western Desert and in North Africa.

Their equipment had been increased and their sisters now felt secure in knowing they would be left in ophthalmic work—a further inducement to efficiency. Furthermore the administration mentioned above was being gradually implemented and they saw themselves, not as isolated members of General Hospitals, as hitherto, but as components in a team of surgeons, sisters, opticians and staff which was spread far and wide through three countries, but integrated and co-ordinated at headquarters. Major-General Hartgill, O.B.E., M.C., was now the Director of Medical Services.

Intra-ocular foreign bodies

The proved policy in this theatre is that all penetrating wounds of the eye are put to the giant magnet as soon as possible after the injury. In this way 50-60 per cent. of all magnetisable intra-ocular foreign bodies are removed in good time. Thereafter prolapses are excised, wound edges cleared and sutured, penicillin applied and a conjunctival covering adjusted. Few attempts at formal removals are made in Forward Areas. If the foreign body does not come through the wound of entry the job is left to colleagues at the Base Ophthalmic Wings. Here radiographic localisation is more precise. For general purposes the equatorial ring method was introduced by Major H. H. Skeoch, R.A.M.C., and although it does not claim to be minutely accurate it serves most purposes. A 26 millimetre ring of silver or stainless steel wire is slipped around the globe into the fornices under local anaesthesia. Two lateral shift pictures are taken and one in the occipito-mental position so that the relationship of the intra-ocular foreign body to the surface of the globe is defined. Care should be taken to differentiate foreign bodies in the lids, sclera and extra-ocular muscles.

On those rare occasions when it is necessary to localize a non-magnetisable intra-ocular F.B. prior to removal, the method of choice is that of the limbal ring as introduced by Brigadier Graham in the Middle East. A 12 mm. ring is firmly stitched to the limbus by four stitches: lateral shift and occipito-mental pictures are taken in the usual way and from these the centre of rotation of a schematic eye can be deduced by erecting perpendiculars to the centre of the ring axis. When due allowance is made for the magnification, generally about 1/6th, the position of the intra-ocular F.B. can be plotted accurately.

The types of foreign bodies encountered showed the progress of the armies. When static or in defence, shells and mortars accounted for most of them but when the army advanced after Cassino, mines became the greatest menace. Mine fields were grafted on to natural defensive barriers and truly " All roads to Rome were mined."

At one time in this period, 60-70 per cent. of all battle eye cases were due to the Schu mine. This is a small anti-personnel mine enclosed in a wooden or glass box and contains practically no metal, it is consequently almost undetectable. The effect on the eyes is to drive numerous tiny grit or glass particles into the cornea and beyond with appalling physiological results. Other foreign bodies found have been bakelite and brass from detonator caps, nickel from bullet casings, aluminium from igniters, stone from the road and bits of bone from a neighbour.

2. *Deep Intra-ocular Infections.*—This has been a major problem and the results of experience will be summarised. First, some attempt is made at prevention of mine eye wounds by the use of the Perspex anti-mine visor. Then, general surgeons at Field Surgical Units are urged to carry out first aid eye treatment aimed at preventing infection such as lid cleansing, lash cutting and the routine instillation of atropine. Next, the skill of the Mobile Ophthalmic Unit is brought to bear and wounds are quickly sealed along with liberal applications of penicillin.

At the Base, protein shock and sulphonamide therapy are added along with more remote surgical measures.

In this theatre penicillin has been used for eye cases during the past year. The consensus of opinion is as follows :—

(*a*) Gtt. penicillin 1,000 units per c.c., are excellent for certain types of conjunctivitis, for dirty sockets and pre-operation sterilization of the conjunctiva.

(*b*) Unguentum penicillin in lanette wax is very useful for seborrhoeic blepharitis and for early application to multiple infected face and lid wounds.

(*c*) Powdered penicillin is insufflated into all penetrating wounds of the eye and is an excellent preventive of infection during evacuation.

(*d*) Intra-muscular penicillin has not proved of great value in the treatment of deep intra-ocular sepsis and there is considerable doubt as to whether the drug enters the ocular media when given to any extent by this route. Intravitreous and subconjunctival injections, especially the latter, offer more hope. There is not the least doubt that penicillin represents a great advance in the prevention and treatment of ocular sepsis.

3. *The Loss of an Eye.*—The practice in this theatre is to perform the Lister frill excision for disorganised eyes when seen at

an early stage and at later stages an enucleation with the implantation of a 14 mm. perspex globe in Tenon's capsule is carried out. The old evisceration operation is practically never done and the usual method of enucleation alone is becoming infrequent. To clean up a dirty socket the application of 2 per cent. silver nitrate paint and penicillin along with upper lid straps to allow ingress of air into the socket has worked wonders. Plastic operations are discouraged and are left for our more expert colleagues at home.

This is but the first chapter in the story of ophthalmology of the Central Mediterranean Forces to date but it may give some idea of what is going on; there is much more to be told.

The ophthalmic surgeons, sisters and staff here have brought this service to a high peak of efficiency: others also outside the theatre have played an important part without which the job could not be done. Brigadier Sir Stewart Duke-Elder has always seen to it that every demand for ophthalmic and optical supplies from this theatre has been met and when these supplies have come we are conscious of what we owe to the workmen and technicians at home who have provided them. Knowing as I do the ophthalmic equipment of practically all the Allied and enemy nations I can say without hesitation that British equipment is second to none.

Finally, my grateful thanks are due to Brigadier H. C. Edwards, Consulting Surgeon, A.F.H.Q., and to Colonel T. Menzies, O.B.E., for constant advice, encouragement and co-operation at at all times.

ANNOTATIONS

Ophthalmology in Race-horses

It must occasionally have happened to most of us to have been asked to give an opinion on the eyes of some animal or other. Sometimes a friend will have brought a dog or cat; and at other times a veterinary surgeon has referred one of his clients to us. But although the late Mr. Lindsay Johnson was reputed to have interviewed a python at the Zoo, few of us can ever have had to pronounce judgment on a race-horse.

A rumour that this year's winner of the Derby had been under the care of an ophthalmic surgeon some time before the race set us wondering what can have been the matter and whether ophthalmic treatment can have had any bearings on the result of the race.

Whether Rosinante was submitted to ophthalmic treatment before Don Quixote's contest with the windmills or the flock of sheep is unrecorded as far as we remember. But Mr. Jorrocks's

opinion "that Mr. Gambado, riding-master to the Doge of Wenice" was the best informed writer on equestrian matters sent us through the pages of *Handley Cross*, but we found little bearing on race-horses in that classic. "Some people make a great bother about an 'oss's eyes, jest as if they have anything to do with his haction" would seem to answer our enquiry in the negative. But whether the condition was a conjunctivitis or iridocyclitis would treatment by lotions or drops—or even penicillin—affect the horse's speed? A dose of cantharides might even make it fly, and thus risk disqualification.

Even such an ignoramus as the present writer has heard of nefarious practices connected with ginger for increasing a horse's mettle; but whether a drop of zinc sulphate applied to the eye would have any effect similar to ginger applied at the other end we really cannot tell. We know that at the sale of Mr. Jorrocks's stud Arterxerxes had been gingered, for it is mentioned in the text, and a bystander is credited with the statement that the "animal would have been quiet enough if you hadn't figged him." In one of Mr. Jorrocks's nightmares he dreamt that the Prince wanted to look at Arterxerxes, and he couldn't find the ginger. But Arterxerxes hardly came into the race-horse category, indeed he seems to have been rather a freak horse, a *lusus naturae*, or as Mr. Jorrocks would have said, a "loose-un by nature."

The great Lexicographer does not help us as he was so ignorant of horse affairs that he made a gross error in defining the pastern. Perhaps it will be best to write no more on the subject in case the Jockey Club might have the law on us. Even if the Journal were acquitted, the writer's sanity might be called in question; just as Mr. Jorrocks's was; and it might even be said that there was too much ginger in our annotation.

Medical Films

The Royal Society of Medicine and Scientific Film Association are co-operating in the collection of a library of medical films. The cinematograph film has afforded a vivid means of presenting many subjects not the least of these are certain technical practices in medicine and surgery. Films have played a great part in the training of the Fighting Services, the lessons learnt by visual impression being more enduring for the majority of trainees. This may also be the case in the future training of the medical student and post-graduate. The films, particularly those reproduced in colour, are capable of presenting technical subjects to a large class concisely and realistically and with much time saving.

In ophthalmology films have been prepared to show operations, retinoscopy, the manufacture of contact lenses and prostheses and

doubtless there are others. So far as surgery is concerned there is no disadvantage to the undergraduate in presenting to him the subject in this way, even the reverse for it saves his time and gives him a concise review of the scope of eye surgery so far as the commoner eye operations are concerned. For the post-graduate, who is specializing in ophthalmology, the film must not be regarded as a substitute for learning eye surgery at first hand in the operating theatre by first assisting a "master" and then performing operations graduated in complexity, with the teacher's assistance.

Hitherto the majority of medical films have been the work of enthusiastic amateurs working on their own. The results will doubtless be much improved by the preparation of films in future by technical experts.

ABSTRACTS

PATHOLOGY

(1) **Harrison, W. T. (Philadelphia).—A case report of osteoma of the orbits resulting in bilateral optic atrophy.** *Amer. Jl. Ophthal.*, Vol. XXV, p. 1233, 1942.

(1) **Harrison** reports the case of a 15 year old coloured girl, suffering from congenital neuro-syphilis, who developed an osteoma involving the roof and apices of both orbits, the entire anterior and upper surface of the sphenoid bone and probably a large portion of its body and the anterior clinoids. Both optic canals were extensively invaded causing optic atrophy and no perception of light in either eye.

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(2) **Asbury, M. K. and Vail, D. (Cincinnati, Ohio).—Multiple primary malignant neoplasms.** *Amer. Jl. Ophthal.*, Vol. XXVI, p. 688, 1943.

(2) **Asbury** and **Vail** report the case of a 26 year old white man in whom the right eye was removed because of malignant melanoma of the choroid, and 4 years later he died of glioblastoma multiforme of the cerebrum. The authors comment that in all the reports examined, and these cover more than 1,500 cases of multiple primary malignant neoplasms, there was no instance of the combination of primary malignant tumours in the eye and in the brain. Their case is therefore unique.

Multiple primary malignant neoplasms occur most commonly in the same organ or in organs of the same system.

In the authors' case the ocular lesion appeared to be originally a benign melanoma which 3 years later showed evidence of malignancy.

The entire right temporal lobe was infiltrated by glioblastoma multiforme and associated with this there was a large cyst. The patient died 8 months after craniotomy and about 4½ years after excision of the right eye. At autopsy there was no evidence of metastases from the malignant melanoma of the choroid.

Convulsions began before the enucleation of the right eye so it is probable that the two neoplasms, one in the choroid, and the other in the brain were present at the same time.

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(3) **Suiderman, H. R. (Toronto, Canada).—Orbital metastasis from tumour of the pancreas.** *Amer. Jl. Ophthal.*, Vol. XXV, p. 1215, 1942.

(3) **Suiderman** describes two cases of orbital metastasis from carcinoma of the pancreas. Metastatic extension is often delayed or absent at autopsy so these cases with orbital deposits are rare. Histological researches show that the ocular muscles are the site of election for metastatic carcinomatous deposits. Invasion is through the blood stream. The orbit involved in each of the author's cases was the left. An account of the post-mortem findings is given in each case.

H. B. STALLARD.

CORRESPONDENCE

MEDICAL FILMS

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

DEAR SIRS,—A catalogue of all the medical films in Great Britain is now being prepared by the Royal Society of Medicine in co-operation with the Scientific Film Association. It would be appreciated if any persons holding films of medical or para-medical interest, who have not already been asked for details, would communicate with the Film Cataloguer, Royal Society of Medicine, 1, Wimpole Street, W.1. By so doing they would not commit themselves or their films, but would enable the catalogue to be complete.

Yours faithfully,

GORDON GORDON-TAYLOR,
Surgeon Rear-Admiral,
President, Royal Society of Medicine.

ARTHUR ELTON,
President, Scientific Film Association.

NOTES

The Scientific Film Association, Medical Committee.

Brief review of the first year's activity

THE Scientific Film Association was formed in 1943 to act as a focus for the collection, collation and distribution of the scientific film and to promote the use of the scientfic film to achieve a wide understanding and appreciation of scientific methods and outlook.

The S.F.A. is governed by a Council which has set up special committees to advise and assist it in furthering the aims of the Association in specialised fields. The Medical Standing Committee was inaugurated in July, 1944, under the chairmanship of Mr. McAdam Eccles. This Committee soon found that its services were in such demand that an Executive Committee was formed in October, 1944, and this has met regularly twice monthly since then.

The preparation of a catalogue of medical films, which is the subject of a letter in our correspondence columns, is a work of outstanding importance, for when completed it will list all the medical films known to exist in Great Britain and will record under each title, a summary of content and a critical appraisal prepared by a panel of experts in the subject matter depicted, as well as the usual details of availability and length. As new films are completed, details of them will be issued in supplements and notes will be given of films withdrawn from circulation. A comprehensive recording system is used which other countries, including some members of the British Commonwealth, are considering adopting. The catalogue will probably be published part by part and first instalments may be expected towards the end of this year. During the second series of medical film programmes presented by the Medical Committee of the Association at the Royal Society of Medicine, 18 films, covering a wide range of subjects and methods of presentation, were screened to audiences averaging over 200 persons. A new selection of programmes is being planned for the autumn which will be devoted to a number of more specialised subjects.

In addition to this work on films which already exist, the committee is drawing up, for publication this autumn, a memorandum on films required to be made immediately for use in teaching. A letter was sent out earlier in the year to the Deans of the Medical Teaching schools of Great Britain; this brought in many detailed replies on which the memorandum will be based. This centralised activity is additional to a large correspondence giving information and advice on all aspects of medical films: equipment, programme selection, film-making, sources of supply, script criticism, and so on.

This correspondence already extends overseas to organisations in Canada, Australia and the U.S.A. and to individual members in other countries.

At the end of the year, the Chairman and Honorary Secretary resigned from their arduous posts. Dr. Ronald MacKeith is elected Chairman for the coming year and Dr. Brian Stanford as Honorary Secretary. Enquiries should be directed to him at the Association address: c/o The Royal Photographic Society, 16 Princes Gate, London, S.W.7.

* * * *

The Leslie Dana Gold Medal

THE Leslie Dana Gold Medal, awarded annually for outstanding achievements in the prevention of blindness and the conservation of vision, has been won this year by Dr. William Zentmayer, of Philadelphia.

* * * *

Sociedad de Oftalmologia de S. Paulo. Election of Officers

THE following officers of the Society were elected on May 7, 1945. President, Dr. Silvio de Almeida Toledo; Vice-President, Dr. Penido Burnier Filho; First Secretary, Dr. Plinio de Toledo Piza; Second Secretary, Dr. Moacir Cunha; Treasurer, Dr. Aureliano Fonseca; Archivist, Dr. Orlando Aprigliano; Chairman, Dr. Silvio de Almeida Toledo.

The official address of the Society is:—Barão de Itapetininga Street, 88, 5° andar, S. Paulo (Brazil), S.A.

* * * *

A Department of Industrial Ophthalmology

THE Royal Eye Hospital, London, has now established a Department of Industrial Ophthalmology and J. Minton, F.R.C.S., has been appointed Ophthalmologist to the Department. The following problems are being investigated:—

(1) Prevention of eye injuries (the type and the efficiency of preventive appliances).

(2) Welders' conjunctivitis (arc eye).

(3) Lens opacities in furnace workers, welders and so forth.

(4) Rehabilitation of the one-eyed worker.

(5) Eye strain of workers engaged on fine close work (radio-valve manufacturers; work on very fine parts in any other industry).

(6) Eye strain due to deficient illumination during work.

(7) Keratitis, conjunctivitis, amblyopia, due to the use of industrial solvents (carbon tetrachloride, benzol, carbon disulphide, aniline dyes and so forth.)

(8) Vision and the selection of staff in industry (visual standards in industry).

Ophthalmologists, industrial medical officers, factory welfare officers, safety managers and other interested persons are cordially invited to refer any of the aforesaid problems, or any other difficulties in industrial ophthalmology, to Mr. Minton, at the Royal Eye Hospital, St. George's Circus, London, S.E.1.

* * * *

Addendum

PROFESSOR FEIGENBAUM asks us to state that the paper in the August number on "Epidemic kerato-conjunctivitis in the Middle East" emanated from the Ophthalmological Department of the Rothschild Hadassah University Hospital, Jerusalem.

* * * *

North of England Ophthalmological Society

THE Meetings of the Society have been fixed as follows:—Manchester, October 27, 1945, at 10.30 a.m.; Leeds, December 8, 1945, Saturday morning; Newcastle, February 16, 1946; Liverpool, March 16, 1946; Sheffield, April 13, 1946; Bradford, May 11, 1946.

* * * *

Marconi Instruments Limited. Establishment of Northern Office

IN order to provide sales and service facilities in the area not possible during the war years, Marconi Instruments Ltd. have now established a Northern office. This is located at 30, Albion Street, Hull, Telephone No. Hull 16144, with Mr. D. J. Taylor, Northern Representative, in charge. Mr. Taylor will personally deal with enquiries, and advise on the Company's many instrument productions.